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Industry survey 2024

Trends and perspectives in the hydrographic sector

Exploring the process of renewing a research vessel fleet

Enhanced job security in marine surveys through AI

Remote hydrography and regulation: mission impossible?

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Industry survey 2024
Our annual industry survey delved into a variety of pertinent topics. This article offers a comprehensive overview of the findings, a task made challenging by the abundance of data. We emphasize the common threads that surfaced and highlight noteworthy results, providing you, as a reader active in the hydrographic sector and related areas, with insights of significant relevance.

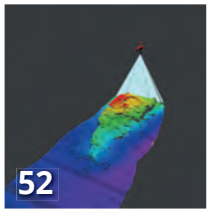
The renewal of a research vessel fleet
When upgrading a research and survey fleet, a collaborative effort is needed to carefully select an optimal new fleet, considering factors like ship type, size, capabilities, and equipment flexibility. This article explores the decision-making processes and experiences of the Royal Netherlands Institute for Sea Research (NIOZ).

Steering shipping towards a sustainable future
Ocean data is instrumental in unlocking short-term carbon savings, essential to meeting industry decarbonizati-on goals by 2030. The UKHO leads in various sustainability projects, emphasizing the significance of hydrography and marine geospatial information in initiatives like green shipping corridors and just-in-time port arrivals.

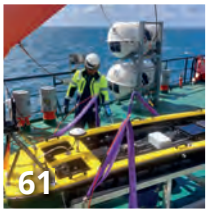
Surveying and sustainability
While sustainability may not be the most exciting topic for some, it is becoming ever more important. Sustainability is the goal of carrying out our normal day-to-day activities without consuming single-use products or depleting our natural resources. This means that everything that we use should be replaced, such as wood by planting forest.

Surveyors and climate resilience
New knowledge and tools are needed if surveyors are to fulfil their critical role along the path to achieving humanity's global climate goals. Surveying systems must also be redesigned in several respects: shifting focus from data collection to analysis, integrating geospatial and climate data, designing for climate resilience and for infrastructure, and collaborative solutions.

Navigating maritime surveying
Interview with Commodore Stewart Dunne, reflecting on his role as the former Hydrographer of Australia and highlighting key achievements, including the success of the HydroScheme Industry Partnership Program. Dunne envisions significant shifts in hydrographic surveying, emphasizing adaptability and the growing demand for maritime environmental data.



Remote hydrography and regulation
The development of unmanned and autonomous surface vehicles in recent years has triggered a new era in civilian and military maritime operations. One of the applications that is likely to benefit from this technological revolution is seabed mapping. Exail decided to make maritime autonomy and remote hydrography a key technology priority in 2017, when it released its first DriX USV.



AI and job security
New workflows that leverage artificial intelligence to achieve the same results as a human being but faster and cheaper will create job losses. From telemarketing to bookkeeping, there really is no stopping the 'rise of the machines'. Job losses have already happened and there will be many more. However, AI replacing highly skilled workers – like marine surveyors – is far less likely.

Cover Story
Encompassing 1,430 km² of seascape and five islands along the Mozambique coastline, the Bazaruto Archipelago National Park boasts distinctive terrestrial and marine habitats with exceptional ecological value. Tasked with safeguarding species of high conservation significance, including sharks, dolphins, marine turtles, and corals, the park is also home to the largest viable population of dugongs (marine mammals commonly known as 'sea cows') in the Western Indian Ocean. This true-color image, captured by a Copernicus Sentinel-2 satellite, highlights the park's beauty. Utilizing open data from Sentinel satellites, monitoring efforts extend to fragile ecosystems globally and include bathymetric applications. (This image contains modified Copernicus Sentinel data).

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- Unrivaled platform stability and data gathering
- Remote-controlled and supervised autonomous operations
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Empowering

We had such a great time putting together this issue of *Hydro International*! We were in touch with so many companies and readers in preparation for this Business Guide, it felt as though we spoke to all of you personally. Impossible of course, but nevertheless: many of our readers responded to our survey and lots of companies became Premium Company Members of *Hydro International*. The Industry Survey has almost become a tradition, gauging the state of the industry and its readiness to invest and identifying bigger and smaller problems. The outcomes of the survey were carefully analysed and reported by Wim van Wegen, our head of content. As well as many other fascinating articles, this issue also includes our Members' company profiles, which provide the broadest overview of manufacturers and service providers active in our business. This combination makes this years' Business Guide the fullest and thickest in years, so most certainly an issue you should keep at hand on your desk or in your bag. Needless to say, you will find all the information online as well (but hey, let's be honest, good old printed magazines still come in handy every now and then!).

"There will always be the need for 'human' oversight for operations at sea and along our coast as the environment is dynamic and everchanging," said a respondent to our survey, who was one of the 68.5% who does not believe that there will be no surveyor on board anymore in ten years' time. This answer to one of the many questions we asked our readership emphasizes the crucial role of the human hydrographer. However, over the last few years, readers have found recruiting and retaining staff the biggest challenge; this has not changed: 38.8% of respondents find this the biggest challenge, followed by training and competency development (17.2%). As this clearly shows, 'human resources' remains top on the list of worries for entrepreneurs and others in the field of hydrography; firstly, finding the right person for the job, and secondly, enhancing their necessary knowledge and understanding on all subdisciplines in hydrography. Obviously, the enduring need for human oversight of survey jobs is intertwined with this challenge. Everyone needs high-quality staff, but they are hard to come by and, when they are finally acquired – through mostly traditional recruitment methods – the next challenge is just around the corner: to keep them up to date with all the latest technological developments. The tech developments are not the issue, as we keep going forward, but the human factor is crucial and at the centre of everything hydrographic, also in 2024.

A combined 83% of respondents agreed or even strongly agreed that *Hydro International* is an empowering force for the hydrographic community. We could not receive a bigger compliment! This is what we strive for, here at Geomares, and our endeavours would be simply impossible without our Premium Company Members. I would therefore like to give a heartfelt thank you to all of them listed in this issue and on the *Hydro International* website. It is through their continued support that we are able to inform the global hydrography community and everyone who feels affiliated with it, with independent, in-depth and quality content on a daily basis via our website, weekly through our newsletter and bi-monthly through our printed and online editions. I sincerely hope that you have a good read and a great 2024!

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Industry survey 2024

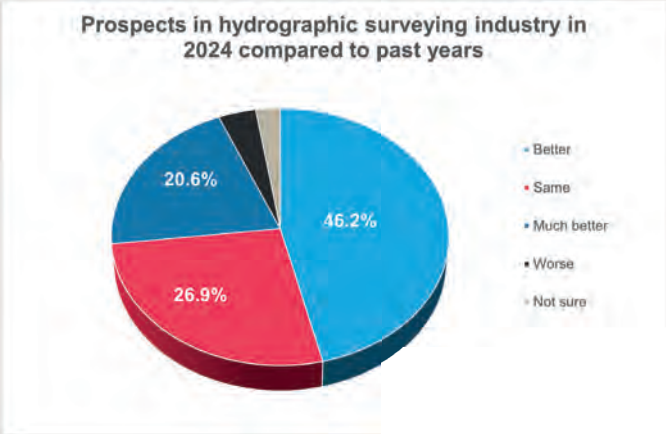
Trends and perspectives in the hydrographic sector

By Wim van Wegen, head of content, Hydro International

How do you perceive prospects in the hydrographic surveying industry in 2024, compared to the past couple of years? When contemplating the hydrographic sector holistically, which areas of investment do you foresee experiencing the most noteworthy developments in the coming years? Will there continue to be a surveyor on board at any stage of the survey process? How do you plan to select and retain new surveyors for the next decade? In what ways do developments such as climate change and sustainability impact your organization's operations? How can the hydrography sector draw insights from other industries? What are the most significant challenges currently facing businesses? Which phase of the survey project poses the greatest challenges for companies?

All these questions were discussed in our annual industry survey. In this article, we present a comprehensive overview of the findings – quite a challenge given the amount of data! – emphasizing the common threads that emerged and highlighting striking results for which we have sufficient indication of their significance to you as a reader active in the hydrographic sector and related areas.

▲ *The* Fugro Frontier *survey vessel played a crucial role in the successful completion of fieldwork for a comprehensive geophysical geotechnical, and environmental site investigation contract related to RWE Renewables' Dogger Bank South (DBS) offshore wind farm and export cable routes. Situated over 110km off the east coast of Yorkshire, England, in the North Sea, this offshore wind farm has the capacity to generate renewable electricity for up to 3.4 million UK homes annually. Encompassing an array area of approximately 1,000km² and featuring over 100km of proposed export cable routes, the project required an extensive survey effort, covering a total scope exceeding 20,000km of survey lines. This serves as a compelling example of the high potential of renewables, as also reflected by this year's industry survey. (Image courtesy: Fugro)*



The hydrographic industry is undergoing considerable transformation, driven by technological advancements that include the ongoing progress in digitization, computer vision and data processing capabilities. This is evident in the miniaturization of sensors and the growing influence of artificial intelligence, marking just the beginning of innovations in hydrography. Is this already having a noticeable impact on the way in which survey companies operate? And, how do hydrographic professionals foresee the trend towards autonomous and remote technologies influencing their work?

No surveyor on board?

"There will always be the need for a 'human' oversight for operations at sea and along our coast as the environment is dynamic and everchanging. Machine learning and automation is a powerful response, but can never match the capacity for agility and adaptation of a human brain," said one respondent to this year's industry survey, summarizing the tone of many others. Of the respondents, 31.5% think there will be no surveyor on board at any stage of the survey in ten years' time, while 68.5% do not believe in this scenario.

Technological change also encompasses the human dimension, as how individuals engage with technological possibilities and establish trust in them are crucial considerations. One respondent commented that on-board survey technicians face challenges in adapting to a vessel's electronic chart system and that ship officers are hesitant to engage with ECDIS track control. The prevailing culture suggests resistance to change, and a complete technical overhaul appears even less likely.

To refer to the much-praised article 'New Horizons for Hydrography' by Mathias Jonas (see text box): "As ongoing digitalization is one side of the coin, communications will be the other one. As we know from our daily life, internet access has become the 'fifth element'. If it becomes widely available at sea, this will definitely be a game changer." Everyone would agree that the increased investment in and development of a variety of internet-connected sensor technologies have accelerated the capabilities of uncrewed and autonomous offshore vessels. One survey respondent agrees that there will be fewer surveyors on board, but points out that: "Satellite links are not yet sufficient to transfer all the data. In ten years' time, based on past evolution, there will still be surveyors out there."

There is also a group that regards the satellite internet revolution as a facilitator of no surveyors on board. "Uncrewed systems and improved global, high-speed communications networks such as Starlink will dramatically advance the ability to conduct autonomous, remote survey operations," one participant writes. But does no surveyor on board really mean there are no surveyors needed? Virtually no one backs that point of view. "If all the equipment is calibrated and in good condition, and the internet connection has excellent reception, the remote surveyor can do his job," states a survey participant. Another respondent believes that modern survey crews will be technically oriented to maintain systems controlled remotely from the office. There may be surveyors on board

Charting the obstacles: hydrographic survey project hurdles

The survey reveals a myriad of challenges encountered by organizations across various phases of hydrographic survey projects. For companies specializing in uncrewed vessel operations in a primarily crewed environment, operational hurdles arise from a shortage of personnel and high fuel and maintenance costs for boats. The procurement process proves intricate due to its extensive nature, demanding meticulous planning to ensure high-quality selection, impartiality and fairness.

The surge in data resolution presents a formidable challenge, requiring extensive time for charting. ECDIS training on ships exposes officers' hesitancy to use ENCs, often due to inadequate surveys, highlighting the need for comprehensive depth information. Challenges also emerge from competition-driven commercial terms and client misconceptions, posing communication and bidding challenges. Limited information on 'other' locations and ambiguous customer needs make survey design unpredictable.

Client expectations, at times quite unrealistic, hinder the adoption of best practices and the complexity of the tendering process varies across clients, demanding diligent pricing conversion. Furthermore, importing technology becomes challenging due to cost considerations and the complexity of navigating challenging marketing conditions. The ultimate challenge for hydrographers lies in precisely identifying and meeting stakeholders' requirements.

Operating in a competitive environment and adapting to leading edge technologies such as USVs remain challenging, especially when clients have not fully embraced these innovations. The tendering process's complexity, coupled with potential oversights by less-experienced personnel, may impact project outcomes. Overcoming challenges related to uncrewed vessels, big data handling and conducting projects under challenging conditions relies on creativity, a versatile team and a constant lookout for technological advancements.

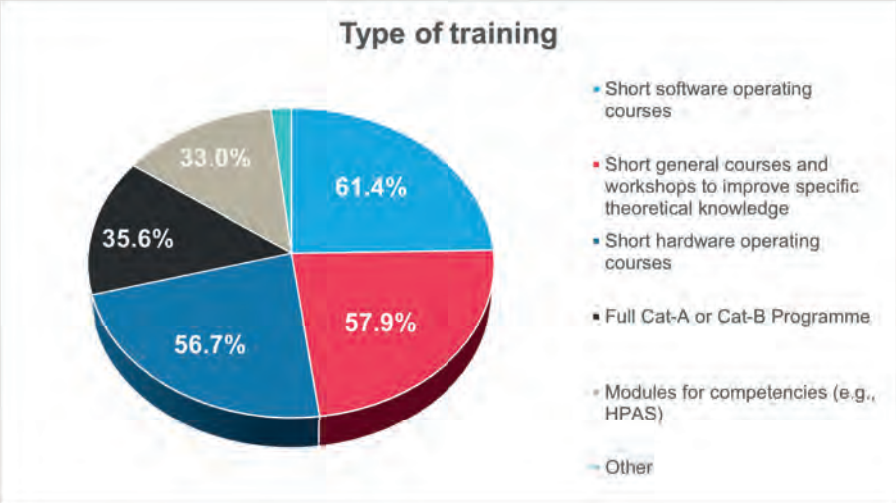
throughout the mobilization and acceptance phases, but they will depart once these are complete, making the classically trained hydrographer a rarity offshore.

Optimizing surveyor selection

The evolution in hydrographic surveying methods demands new skills for the future. Furthermore, the organization of surveying processes will undergo a distinct transformation. How does this transformation align with the recruitment strategies of companies and organizations, and what competencies should staff prioritize as part of their skill set? These questions were focal points in this year's industry survey edition.

The hydrographic sector is grappling with a talent shortage amid rapid maritime industry growth. Skilled hydrographic technicians are in high demand, surpassing the current supply. As mentioned earlier in this article, technological advancements require professionals in the sector to acquire a new set of skills. Hydrography, a complex profession, demands expertise in areas such as sonar technology, vessel navigation, geodesy and data processing. The swift technological evolution underscores the need for a dedicated talent pool to integrate innovations into existing workflows. While commendable programmes address various aspects of the profession, there is a growing demand for a standardized curriculum to better prepare students for hydrography careers.

Answers to the question "How will you select and keep new surveyors for the next ten years?" varied, but a common thread emerged. Perhaps the following response is a thought-provoking way to stimulate the discussion: "While acknowledging the broad nature of this question, in my perspective, a proficient surveyor should exhibit discipline in surveying. Additionally, they must possess a robust knowledge and understanding of every facet of data collection systems, rather than merely being capable of pressing 'F5'." Many responses concurred with the observation that selecting and retaining new surveyors for the next decade presents challenges that require focusing on new surveyors with knowledge of AI, autonomy and the quality control of data that has been processed automatically.



Making sense of sensor data

In his insightful publication 'New Horizons for Hydrography' (*International Hydrographic Review*, Volume 29(1)), Mathias Jonas explores the evolving landscape of hydrography. He predicts that, with the increasing dominance of flying, floating and diving remote-controlled or autonomously operating units as instrument carriers, their outstanding cost/benefit ratio will drive the miniaturization of sensor technology and reduce energy consumption. Jonas emphasizes the ongoing digitalization of hydrographic processes, starting from sensor technology and extending to the collection, transmission, processing and dissemination of hydrographic information. This transformation is expected to yield unprecedented volumes of data in terms of both scope and quality. However, Jonas notes that a crucial missing component is a digital ecosystem capable of hosting the diverse marine data, facilitating sovereign and sustained management of these extensive data repositories.

Another much shared opinion is that the evolving role of hydrographic surveyors in the digital age requires creativity and common sense. "We are seeking individuals with a multidisciplinary background, capable of applying data science principles across a diverse spectrum of data collection, analysis and production," is one response that summarizes the general feeling. Additionally, programming skills, database and data management capabilities, telemetry and robotic knowledge belong to the backpack the hydrography professional of today and tomorrow should carry.

Attracting skilled people

There seems to be a broad consensus that the hydrographic sector should maintain control while formulating a robust strategy for a proficient workforce. After all, employing all kinds of tricks to recruit new personnel is deemed incompatible with the industry's typically pragmatic approach. Furthermore, survey participants highlight the availability of ample tools to devise an effective strategy for recruiting individuals with the requisite skills.

Improved education and training for surveyors is essential to enhance their understanding of data acquisition, including mandatory knowledge of all sensors. Some respondents propose increasing compensation for on-board personnel to rectify the imbalance where freelancers often earn more than in-house experts who, in turn, provide training. To mitigate stress and enhance safety, adopting two-week rotations, despite the associated costs, is crucial. The unsustainable practice of selecting personnel based solely on cost requires individuals on vessels to travel from all over the world. Additionally, surveyors in rotation should receive training equivalent to their onshore counterparts to address the current issue

▲ *The Hugin USV is anchored at Ørsted's Anholt wind farm, ready to be deployed for offshore metocean measurement campaigns in the wind farm industry. This stands as a good example of the ever-increasing role of autonomous survey methods in hydrography. (Image courtesy: Ørsted)*

of them feeling unsupported. These are intricate challenges with no singular solution, as various contributors point out.

Revisiting the tools already available to our sector, we find valuable guidelines to support our efforts. Noteworthy examples emerge from our analysis of the input received. Aligning with the Ocean Mapping curriculum requirements, it is advisable to adopt the best practices outlined in the GEBCO Cook Book. Regarding the training of new hires, preference should be given to those holding Hydrographer Category A or Category B certification.

Several organizations emphasize a personnel policy structured around certified surveyors with qualifications such as Category A or B in hydrographic surveying, complemented by practical experience and a commitment to staying abreast of technological advancements. A proactive approach in anticipating methodologies and dedication to upholding best practices for ensuring data quality are also valued attributes. "I think the HPAS system will be a good indication of who is doing what. We will have to implement HPAS when hiring new people. IHO certification must become a requirement at some point for people working offshore," one survey participant said. The

The lack of skilled personnel and the difficulty in attracting new young talent emerge as recurring concerns, underscoring the gravity of the situation

Hydrographic Professional Accreditation Scheme (HPAS), crafted by the International Federation of Hydrographic Societies (IFHS), aims to aid and bolster qualified hydrographic professionals. It provides a platform for individuals to showcase their competence, capability and career development, offering valuable support to those with experience in the field.

To attract and retain new surveyors, offering competitive compensation and instilling confidence in job security is essential. Several respondents noted the significance of this approach.

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The hydrographic industry's major challenges

The question regarding the most significant challenges faced by the hydrographic industry, both at present and in the near future, sheds light on the prevalent issues. The lack of skilled personnel and the difficulty in attracting new young talent emerge as recurring concerns, underscoring the gravity of the situation. In Australia, the scarcity of hydrographic surveyors, compounded by lower wages compared to the private sector, poses a significant obstacle in hiring and retaining experienced professionals. The US region also faces a pronounced scarcity of staff and a concerning deficit in competence. Skilled staffing stands out as a major overarching issue affecting various business aspects. Compounding the challenges is the limited availability of training and development courses in the hydrographic industry catchment area. This scarcity necessitates additional expenses to send personnel abroad for studies or to invite experts to conduct on-site training, adding to the complexity of talent development.

Other challenges include high contractual risk in specific sectors and the impact of extreme weather events on operational risk management. Client willingness (or lack thereof) to share these risks adds a layer of complexity. These challenges also require attention and emerge repeatedly in an analysis of the results of the industry survey.

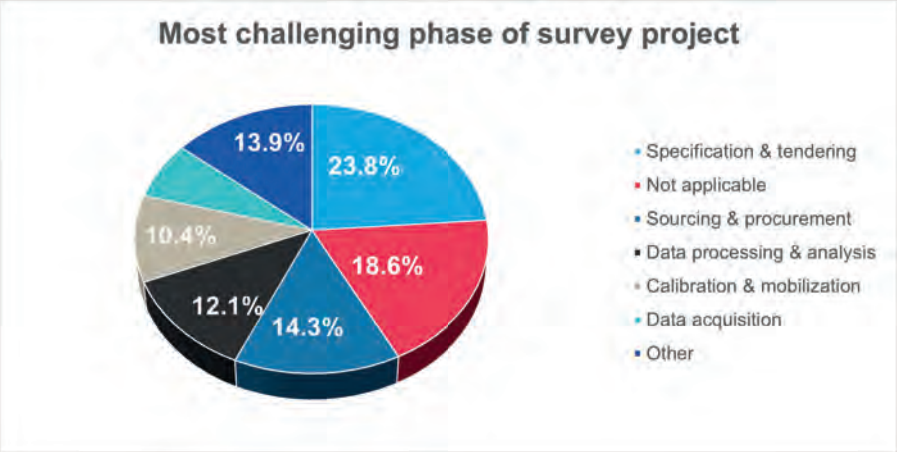
Technology poses additional challenges for the hydrographic sector. Rapid advancements mean that staying up to date is difficult, and the introduction of new technology often requires substantial investments. Securing funding for state-of-the-art equipment, software and survey operations remains a key concern. Despite the demand for enhanced production, there is hesitancy to allocate the necessary funds. Simultaneously, there is a push to invest in greener engines and more sustainable survey vessels, adding complexity to the equation. Balancing these priorities becomes increasingly intricate amid growing cost and efficiency pressures. Technological progress prompts significant industry shifts, such as moving away from offshore crewed activities and replacing them with autonomous solutions, prioritizing quality control and fostering remote work. As one respondent noted: "The pursuit of sustainability and our net-zero survey ambitions face challenges, primarily stemming from the limited technological innovations available for powering survey vessels." While it should be noted here that innovative autonomous survey solutions are on the rise, the survey highlights a scarcity of affordable options and a desire for a broader selection.

Gaining knowledge

Our survey underscores the importance of training as a fundamental element to acquire the necessary knowledge for effective operation in the hydrographic sector. Respondents expressed diverse preferences regarding the type of training they wish to pursue, with multiple options available for selection.

Short software operating courses were favoured by 61.4% of the participants, and 57.9% of respondents expressed interest in short courses that focus on hardware operation. A preference for short hardware operating courses was indicated by 56.7%. A significant portion, comprising 35.6%, showed interest in pursuing a comprehensive Cat-A or Cat-B programme. Furthermore, 33% of the respondents expressed a desire for modules that provide competencies aligned with assessment schemes such as HPAS. Only a small group of ten respondents selected the 'Other' category, suggesting varied preferences outside the specified options.

These insights offer valuable perspectives on the diverse training needs in the hydrographic community, reflecting a range of preferences for skill development in software, theoretical knowledge, hardware operation, comprehensive programmes and specific competencies aligned with assessment schemes.



Growth perspectives in the hydrographic sector

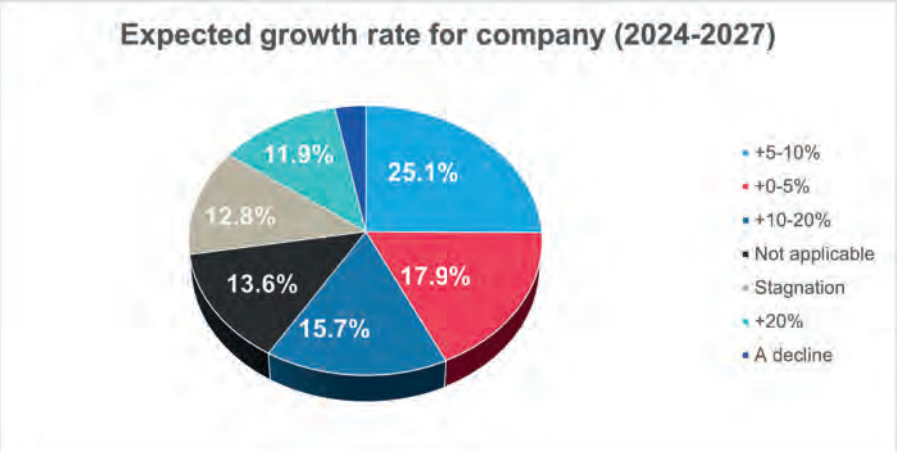
The survey reveals diverse expectations for growth among hydrographic companies between 2024 and 2027. A significant portion anticipates a modest growth rate of 5–10% (25.1%), followed by growth of 0–5% (17.9%) and 10–20% (15.7%). Some respondents foresee stagnation (12.8%), while others project a decline (3%), and a notable 13.6% marked the question as not applicable to their circumstances. To further explore these projections, let us take a closer look at where respondents see the growth opportunities, and what is behind the often optimistic outlook.

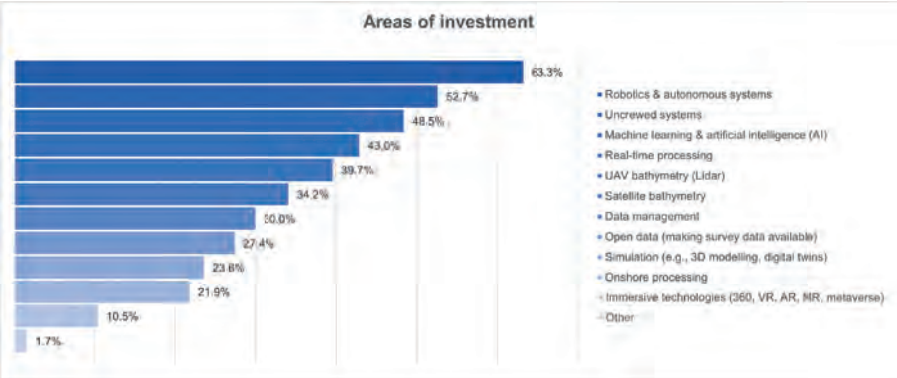
Technology seems to be a vital component of the optimism regarding expected growth, and many survey participants reported a bigger order portfolio. Technological developments that help with this range from the vessels used for surveys, to survey instruments, to cloud systems to handle the colossal amount of data. Significant growth is regarded as realistic due to the introduction of uncrewed mapping solutions for complex work, including the inspection of underwater pipelines and onshore infrastructure. One response provides a good example:

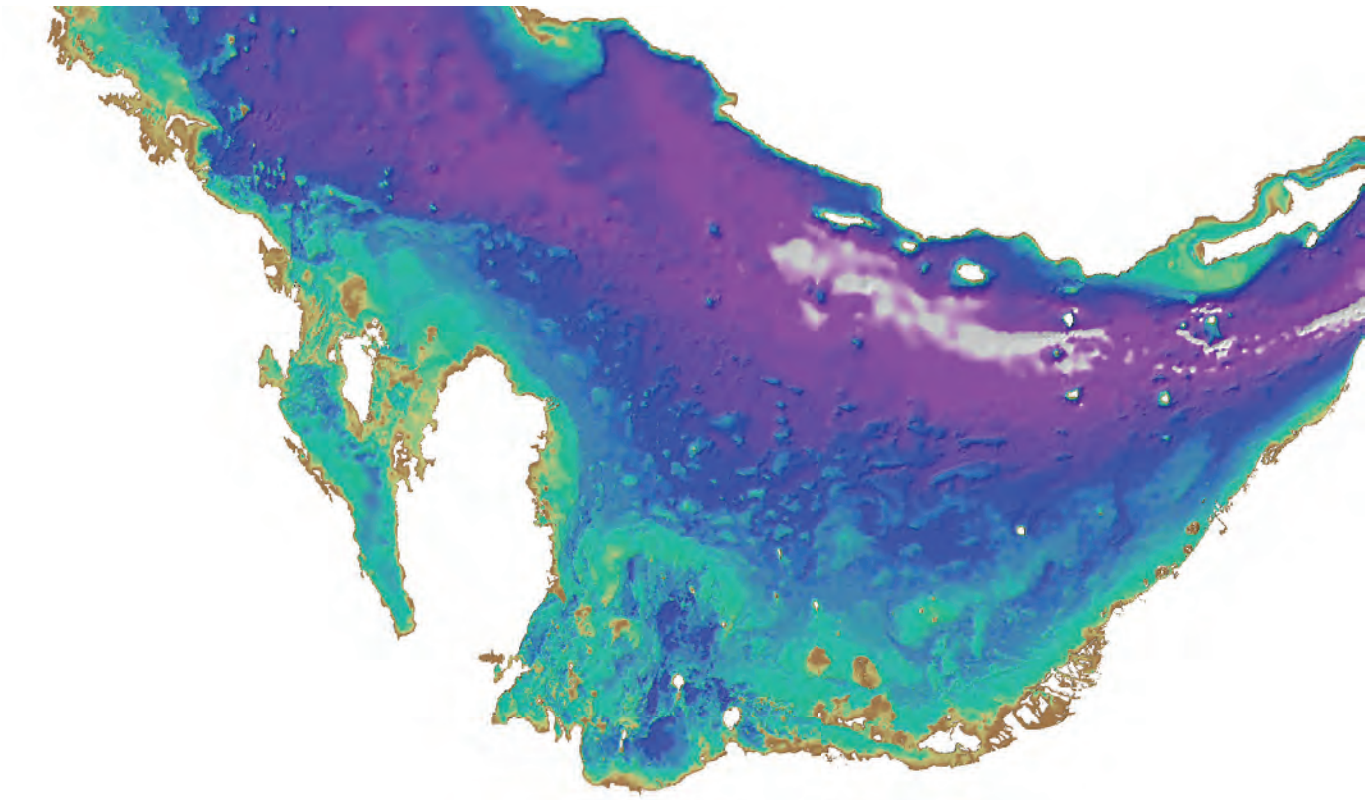
transforming the manual system into a digital cloud data system and transitioning from a crewed to an uncrewed system could potentially slash production costs by 5–10%.

Renewable energy remains a growth pillar for the sector, as shown by the following survey responses: "The market for hydrographic surveying in my country is expanding and companies are now willing to get professional surveys done with the required accuracies and standards," and: "Despite the challenges facing offshore wind, the anticipated resilience of coastal areas and the growth in the blue economy are poised to drive expansion in our industry."

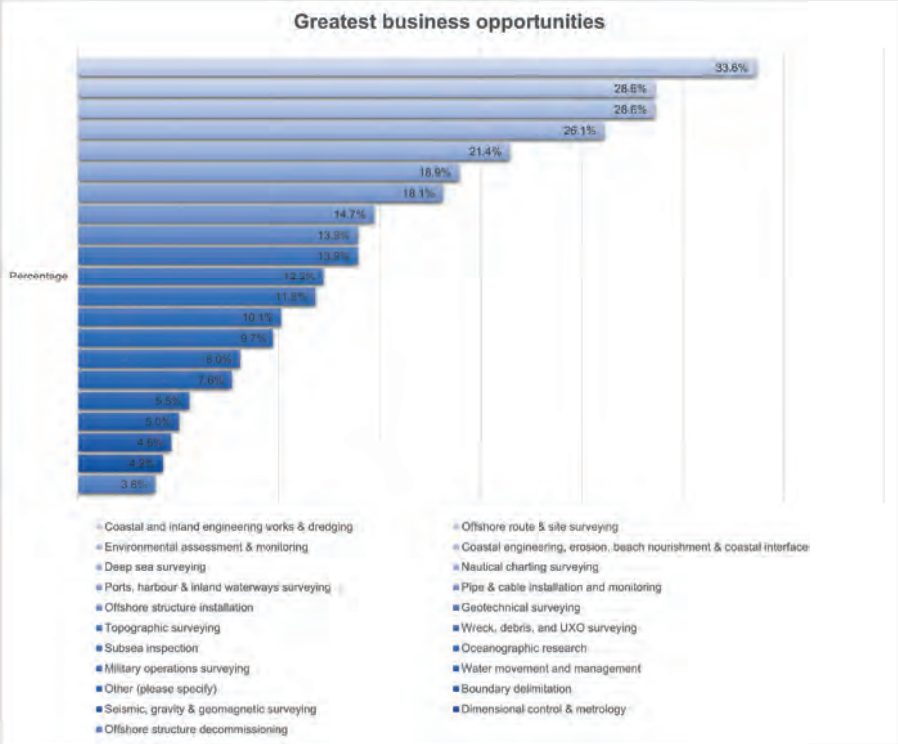
However, not everyone is so positive, as there are parts of the world where the economic outlook is less bright and the conditions for running a hydrographic survey business are volatile to say the least. An example of this is expressed by one respondent: "The oil and gas industry relies heavily on hydrographic services. Unfortunately, the local state oil company is experiencing a decline, causing a ripple







▲ *The hydrographic industry is undergoing significant transformations, driven by advancements in data processing technology, a key pillar in this evolution. The illustration here provides a compelling example from the hydrographic sector, highlighting the vital role of digital elevation data in tendering, planning and hydrodynamic modelling. EOMAP's Multi-Source Bathymetry Grid (MSB) integrates bathymetric information from diverse sources, combining recent satellite-derived bathymetry, nautical charts and on-site survey data into a seamless grid. (Image courtesy: EOMAP)*



effect throughout the entire supply chain, encompassing both goods and services. In the past decade, the industry has grappled with the repercussions of low reference prices set by contractors and delayed payments to suppliers. The prevalence of corruption and an unstable energy policy further dampen confidence, discouraging much-needed investment and hindering growth in the hydrographic sector."

Investment priorities

The question that probably piqued the most interest among manufacturers of hydrographic hardware and software solutions was: "When considering the hydrographic sector as a whole, which areas of investment do you anticipate will see the most significant developments in the coming years?" In envisioning the future of the hydrographic sector, professionals anticipate notable advancements in key investment areas, in particular robotics & autonomous systems, named by 63.3% of respondents, closely followed by uncrewed systems, at 52.7%. Machine learning & artificial Intelligence emerge as critical focus areas, capturing the attention of 48.5% of professionals, while real-time processing is deemed essential by 43% of respondents. UAV bathymetry (Lidar) and satellite bathymetry are also recognized as crucial, named by 39.7% and 34.2% of respondents, respectively. These insights underscore the industry's commitment to technological innovation and automation in shaping its future landscape.

The willingness to invest is always subject to nuance: what are priorities for the shorter and longer term, and what are circumstances that allow investment? And what is smarter: to invest in technology or staff? Some answers were very telling, such as the following: "The growth is currently spectacular, but the big question is how sustainable this is. Currently, growth is driven by new wind farm developments, while surveys in the operations and maintenance phase are coming under pressure and becoming more and more a commodity. As soon as there is a regulatory framework around autonomous vessels, this will potentially be disruptive in the market. The current growth in the market also translates into major growth within our organization, with human capital being the inhibiting factor."

Discussing investment in cutting-edge technology ignites the imagination: could it perhaps act as a magnet to attract new students, drawn in by the thrilling prospect of contributing to the development and advancement of surveying through the use of innovative technologies such as autonomous systems and AI/ML, as one respondent suggests? The discussion comes full circle, encompassing a wide-ranging debate on the captivating possibilities within the field.

What about AI?

In recent years, artificial intelligence (AI) has consistently been a focal point in the industry surveys conducted annually by *Hydro International*. However, this year was notable in that it was mentioned much less by survey respondents, who apparently no longer feel the need to specifically name it as a key topic, despite its increasing presence in the sector. Our analysis indicates that individuals, including hydrographic professionals, are acclimatizing to the integration of AI, recognizing it as an integral component of contemporary hydrographic equipment. This includes its application in object detection and data editing. In the commercial marine sector, the adoption of AI-based technologies is transforming from optional to imperative, creating a heightened demand for bathymetric and hydrographic solutions.

The accessibility of cost-effective computational resources is driving the unmistakable presence of AI in marine geomatics, ocean sciences and hydrography. While mathematical models wield significant power, their efficacy depends on validation through calibration points. Similarly, AI relies on reliable observations for effective emulation and learning, capturing the nuances of real life.

This year's industry survey indicates that professionals in the hydrographic industry have embraced and adapted to AI. However, as the momentum of AI technology intensifies at an exponential pace, the sector anticipates more remarkable applications of this transformative technology in the foreseeable future, with new AI-related technologies on the horizon.

Conclusion

This edition of the *Hydro International* annual industry survey delves into the nitty-gritty of what will shape the hydrographic sector in 2024 and beyond. The industry is going through major transformations thanks to the advances that high-end technology brings, such as in digitization, computer vision and data processing. The miniaturization of sensors and the growth in AI, which has matured and is now much more than a buzzword, are just the tip of the iceberg in hydrography's innovations. While the role of surveyors is debated, with varying opinions on whether autonomous monitoring and survey methods will make them obsolete on board, human oversight is considered necessary by the majority of respondents, who underscore the adaptability and agility of the human brain. The survey highlights the urgent need for skilled personnel and the challenges being faced in attracting and retaining talent, especially amid all these technological advancements. It also explores the impact of such advancements on operational efficiency, including the satellite internet that is revolutionizing remote survey operations. The growth prospects in hydrography reveal mixed expectations.

The willingness to invest is always subject to nuance: what are priorities for the shorter and longer term?

On the one hand there is optimism, driven by tech leaps and market expansions, for example in renewable energy. However, challenges are never far away, especially in regions facing economic decline and volatility, which impact hydrographic services in sectors such as oil and gas. Our survey underscores the industry's resilience and determination to navigate these challenges while embracing technology advancements, fostering a workforce armed with evolving skills, and charting a course towards a sustainable and innovative future. ■

About the author

Wim van Wegen serves as the head of content at *Hydro International*, overseeing both print and online publications for one of the world's foremost hydrography trade media brands. In this role, he not only contributes columns and feature articles but also conducts interviews with renowned experts in the sector. Holding a bachelor's degree in European Studies from NHL University of Applied Sciences in Leeuwarden, the Netherlands, Van Wegen also holds the same position at *GIM International*, the leading global magazine for the geospatial industry.

▲ *The evolution in hydrographic surveying methods necessitates acquiring new skills for the future, yet envisioning a hydrographic sector devoid of crews and offshore surveyors is deemed unlikely. (Image courtesy: NOAA)*

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Exail is a leading high-tech industrial company specializing in cutting-edge maritime sensors and autonomous platforms. The company's expertise includes surface and subsea inertial navigation systems, subsea positioning and subsea imagery solutions, as well as surface and subsea maritime drones and robots (USVs, AUVs and ROVs). With a strong entrepreneurial culture, Exail's innovative systems and solutions deliver unrivalled performance, reliability and safety to clients operating in the severe maritime environments of offshore energies and ocean sciences.

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Exail was formed by ECA Group and iXblue joining forces in 2022. It is a subsidiary of Exail Technologies, a family-owned company specialized in high technology.

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Redefining oceanic exploration in Dutch marine science

The renewal of a research vessel fleet

By Wim van Wegen, head of content, Hydro International

When contemplating the replacement of a research and survey fleet, a collective effort is required to meticulously curate an optimal new fleet, considering factors such as ship type, size, capabilities and flexibility for equipment interchangeability. The flagship, often the largest seagoing research vessel, receives special attention. In this article, the Royal Netherlands Institute for Sea Research (NIOZ), which is actively involved in such an operation, provides valuable insights into its decision-making processes and experiences. This is of significance to the entire Dutch marine scientific community and maritime sector, and can provide help in formulating a comprehensive set of requirements for a new fleet. The formidable costs underscore the gravity of this endeavour, necessitating a careful and strategic approach.

The marine research and maritime sectors of the Netherlands are among the international top. To maintain this position, continued investment in marine scientific knowledge and technological innovation and the replacement of the associated seagoing infrastructure are indispensable. It is for these reasons that a replacement operation involving three research vessels is currently in full swing at the NIOZ, which manages the Dutch national research fleet. The first ship, the RV *Adriaen Coenen*, was completed in 2022 and work is still underway on replacing the two larger research vessels.

The NIOZ operated three aging research vessels, ranging from approximately 30 to 50 years old. Recognizing the imperative to innovate beyond their economic lifespan, coupled with evolving functional needs, the institute sought a contemporary solution. While research vessels are occasionally refurbished, this proved unfeasible for the trio due to a prior refurbishment and the inherent limitations of repeated renovations. This prompted the pursuit of an entirely new fleet equipped with the latest technology, features and capabilities to meet the evolving demands of marine research.

Next-generation research vessels

The *Adriaen Coenen*, in use by the NIOZ since 2022, is mainly used for crew and cargo transfers in the Wadden Sea, an intertidal zone located in the south-eastern part of

▲ *This photo captures the momentous launch of the research vessel* Wim Wolff, *meticulously crafted by Thecla Bodewes Shipyards in Harlingen, a picturesque Frisian town nestled along the Wadden Sea. (Image courtesy: Thecla Bodewes Shipyards)*

▲ *Artist rendering of the RV* Anna Weber-Van Bosse *at sea. (Image courtesy: NIOZ)*

the North Sea. Various research will be conducted with this Wadden ship, ranging from climate change to biodiversity. The *Adriaen Coenen* is the successor to the 50-year-old RV *Stern*. The RV *Adriaen Coenen* is equipped with workplaces for two crew members and 12 passengers, such as scientists, research assistants, students and other passengers. With a shallow draft of just 85 centimetres, the ship is able to pass the tidal flats in the Wadden Sea around high tide and dry up on sandbanks, partly thanks to the use of water jets.

RV *Anna Weber-van Bosse*: features and specifications

General
30 t stern A-frame, 150 degrees
25 t side A-frame
DP2
Dyneema coring cable, 8km
Dyneema opto-electrical-mechanical cable, 9km
Heave compensated winches
U-shape anti-rolling tank
30m piston coring
Container hold for 4 x 20' container labs
D-deck 20' container labs, 15 positions
Deck hangar

Living lab
3 x 40' living lab container positions
- Energy system (e.g. H2)
- Wind-assisted propulsion
High bandwidth satellite connection
Hi-res motion sensors
Open data equipment

Acoustics
Low underwater radiated noise
Minimal bubble sweep down
Drop keel
USBL pole
Shallow water multibeam
Deep water multibeam, 0.5° x 1°, up to 8km depth
Hydrographic singlebeam echosounder, full ocean depth
Sub-bottom profiler, full ocean depth
USBL: deep and shallow/wide angle
Wideband splitbeam scientific echosounder

The Wadden Sea research vessel RV *Wim Wolff* will replace the RV *Navicula* in 2024. As it will be used for work in the shallow Wadden Sea, it must have a shallow draft. To make the vessel future-proof, high environmental requirements are being imposed on the almost 37-metre-long and approximately 10-metre-wide ship. It meets the sustainability ambitions of NIOZ, which would ideally like to sail emission-free within about ten years. For this reason, the ship is being built with a sustainable diesel-electric power management system that can easily be adapted according to new technological insights and energy sources.

The ocean-going ship *Anna Weber-van Bosse* is being built at the renowned Astilleros Armon shipyard in Vigo, Spain, after they came out best in the mandatory European tender on price, technical offerings, sustainability, project planning and organization and innovation. Gert-Jan Reichart is closely involved in the building of the *Anna Weber-van Bosse*. This state-of-the-art vessel will soon be conducting oceanographic research all over the world. Construction started this month (December 2023) and the ship should be delivered in autumn 2025, becoming operational a few months later. Compared to the current RV *Pelagia*, the RV *Anna Weber-van Bosse* will have much larger laboratories, more accommodation and more modern equipment.

Choosing the right equipment
While all of the vessels in the new fleet have many innovative and noteworthy features, we pay particular attention here to the flagship, the *Anna Weber-van Bosse*. This vessel is intricately designed, with a drop keel equipped with a myriad of sensors. The expansive gondola beneath the *Anna Weber-van Bosse* captures the imagination, as it boasts an array of sensors, including deepwater, ocean-depth and

shallow-water multibeam. The drop keel further houses a series of acoustic Doppler current profilers operating at various frequencies, facilitating diverse measurements. Additionally, the vessel incorporates an underwater acoustic positioning system (USBL) in multiple lengths, featuring an extendable pole for flexible usage in both deep and shallow waters and accommodating the distinct frequencies required for various depths.

"We started putting together the equipment for the *Anna Weber-van Bosse* more than five years ago," says Gert-Jan Reichart. "This started with consultation rounds at the various universities that will use it, as the ship is a national facility of the Netherlands. The key question that we asked all potential stakeholders was: what do you need? The specifications were drawn up based on this, resulting, among other things, in a foremast with all kinds of equipment for atmospheric measurements and an aft deck that is as large as possible to accommodate all kinds of third-party equipment. In this way, we tried to make the ship as widely applicable as possible."

Onboard a new-generation research vessel

"We are also working on renewing equipment such as AUVs, ROVs and gliders. There is sufficient space on the new flagship for this type of larger equipment, and that was quite a challenge because, compared to the huge research ships owned by France and Germany, we want to limit our ships to a maximum of 80 metres, to ensure their flexibility in coastal areas as well as the open seas. As a result, we had to build as efficiently as possible," Reichart explains. "We also work a lot with the container concept. These containers are all designed with a specific purpose, such as measuring traces of oxygen in bottom water or traces of methane in seawater. In fact, they are laboratories that can be changed per expedition, depending on requirements. The ship itself has very few laboratories, but is modular."

Communication between the crew and researchers engages two distinct systems. One communication system is tailored to the crew and nautical activities, and the other is an internal system dedicated to the scientific team, providing the ability to observe and monitor all pertinent information during expeditions. Development of this system is currently underway for the flagship *Anna Weber-van Bosse*. Although the precise details are yet to be finalized, it is envisioned as an advanced web-based platform that allows individuals to access data from anywhere. The selection of software, automation and related elements has been deferred until the last moment, due to the rapidly evolving nature of technological developments. This will ensure the incorporation of the latest advancements.

Advanced sensors

When it comes to integration of the hardware, particularly the advanced sensors onboard, the fixed gondola is of great importance. As researchers also want to be able to work in poor conditions, the weather window must be as large as possible in order to conduct the best and most research possible. A good example here is research into currents in the North Atlantic Ocean, as the time when weather conditions are at their worst is the most scientifically relevant. While a lot of work can be conducted with gliders and remote survey methods, you sometimes just have to get out there. Gert-Jan Reichart explains: "That is why we want our new flagship to be very stable, even under extreme weather conditions. We tested all of this extensively at MARIN, the Maritime Research Institute Netherlands. All the fixed measuring equipment is located in the gondola under the ship, such as the multibeam and the drop keel whose equipment can be changed, making it very flexible and versatile. The research vessel is also equipped with thousands of switches to record all kinds of ship behaviour variables. These can be monitored, making it possible to generate the basic data for creating a digital twin of the entire ship. This allows you to optimally map the operation of the ship."

▲ *The commencement of the construction of the RV* Anna Weber-van Bosse *at Armon Shipyards in Vigo on 11 October 2023, was marked with the symbolic welding of the 'coin for good luck' by Gert-Jan Reichart and Henk Oenema on behalf of NIOZ. (Image courtesy: NIOZ)*

Additional facts

Dynamic positioning (DP) is built into the latest NIOZ fleet. However, the *Anna Weber-van Bosse* is equipped with DP2, due to the safety considerations that necessitate extra redundancy for ecological research work near wind farms.

The vessels do not have any real cranes but use A-frames – especially at the back of the research vessel. A-frames are used to take sediment cores, water samples and so on. The aft deck surface has been enlarged to its maximum so that it can be used as efficiently as possible, particularly because of the requirement to accommodate heavy equipment from Germany.

The purchase of additional parts of the new NIOZ fleet, for example AUVs, are all European tenders because they involve Dutch taxpayer's money. The gliders and AUVs have been purchased, while the tender procedure for the ROV is still ongoing. Updates on this are expected later in 2024.

Weatherproof

Another important consideration is how to take the varying duration of expeditions and, above all, their changing circumstances, into account. Reichart: "The *Anna Weber-van Bosse* was built with an enormous weather window, taking into account the different climates and associated conditions in which the ship will operate. Another thing that has been carefully considered is the crew capacity: the cabins can be used with both a single (standard) and double occupancy. This means that over 30 scientists can join an expedition, for example if many samples need to be taken. Of course, IMO regulations stipulate a minimum number of crew members."

Niche market

Compared to other countries, the NIOZ will find itself in a very interesting niche when the new *Anna Weber-van Bosse* is ready. "We want a ship that is complementary to other fleets and other countries. Germany has two very large ships, the *Meteor* and the *Sonne*, one in the Atlantic Ocean and the other in the Pacific, which they generally do not leave. This is a completely different way of working, and the Germans plan far in advance, while we try to be more flexible. We are still talking about a year, but that's quick compared to the Germans, who are planning three to even five years ahead," Reichart explains. The French have the *Atalante* and the *Marion Dufresne*, which are also much larger vessels.

The Netherlands has therefore positioned itself somewhere in between, with a mid-size ship, which represents a niche in the oceanographic research field. While small ships often only conduct coastal research, the *Anna Weber-van Bosse* will be a mid-size ship that is capable of expeditions in seas such as the North Sea and the Baltic Sea, but also in the open ocean.

Sustainability and climate change

To what extent is sustainability of the new fleet being taken into account? Gert-Jan Reichart points out that the *Anna Weber-van Bosse* is built as sustainably as possible, with the cradle-to-cradle concept in mind: "We cannot sail fully electric, but the biggest research vessel will be equipped with a large battery pack suitable for peak shaving. We are trying to prepare the ship for the transition to methanol, so that as soon as this becomes available and is realistic, the ship can be converted. Of course, the ultimate aim is green methanol."

Critical for Dutch researchers is the ability to sustainably advance their investigative pursuits. This encapsulates the necessity of Dutch investment in a new research fleet, to ensure that researchers can continue their work in an environmentally conscious manner. The NIOZ leads this initiative, managing state-of-the-art equipment tailored for the national marine research community. Through these efforts, a foundation is being laid for continuous scientific exploration and a commitment to sustainability in marine research practices.

Vessel availability

A new fleet of research vessels is a major leap, but how do you ensure that they are used optimally? The fleet is managed by the National Marine Facility, a division of the NIOZ with a vessel committee that examines fleet deployment. The ships are available to anyone in the Netherlands who conducts peer-reviewed research funded by the EU or the Dutch Research Council (NWO), of which the NIOZ is part. The NWO funds the vessels and checks whether there are researchers who need to use them. Via the Marine Facilities Planning website (marinefacilitiesplanning.com), researchers can see where the ships are, what they have worked on and future planning. Requests for particular expeditions can also be made on the

▲ *Featured in NIOZ's 2019 annual report, this illustration unveils the new research fleet. (Image courtesy: NIOZ/YouTube)*

▲ *The RV* Adriaen Coenen*: shallow draft of 85cm, seating for two crew and 12 passengers – ideal for Wadden Sea tidal flats, able to rest on sandbanks during high tide. (Image courtesy: NIOZ)*

website. The Marine Facilities Planning platform is a joint NIOZ, NERC and Maas Software Engineering project that could be made available to other organizations.

Dos and don'ts

What are the dos and don'ts when purchasing a new research vessel? "One do is absolutely to involve as many people and organizations as possible who can contribute their valuable knowledge and skills," says Reichart decisively. "Approach this as broadly as possible: geologists, biologists, physical oceanographers and so on. All of these scientists with their different perspectives have jointly contributed to our package of requirements. This gives you the widest possible multipurpose ship. In other words, don't decide for yourself what you think is best for the people who will work with the new fleet, but organize this very explicitly in broad consultation. In fact, it is a beautiful thing: the process of defining your flagship together."

Reichart continues: "We also involved the crew of the previous flagship, the RV *Palagia*, as they will work and live on the new vessel for the next 20 years. Crew members often focus on completely different things, which is very valuable. We looked at how to maximize flexibility, with as many sensors as possible, but for the crew, the people who work on the ship, it is of course very important that it is a home.

"It's crucial to exercise caution and avoid prolonging the process excessively. This is essential to mitigate the risk of falling behind amid evolving realities and emerging technologies, which might lead to your ship becoming outdated," advises Reichart. He suggests: "Don't commit to all kinds of technologies at the very beginning of the replacement process, but save that for later when the project is in its final phase. A good example is the large screens for the planning table: you only need to purchase these a few months before delivery. After all, you don't want systems that are already becoming outdated when you first set sail!"

Conclusion

In a quest to modernize its aging research fleet, the NIOZ is spearheading a meticulous replacement operation, prioritizing factors such as ship type, size and equipment flexibility. Its flagship, the *Anna Weber-van Bosse*, stands out with innovative features such as a drop keel with advanced sensors and a modular design for diverse research needs. Sustainability is a core focus, aiming for a cradle-to-cradle concept and future adaptability to green methanol. The fleet's management by the National Marine Facility ensures widespread accessibility for peer-reviewed research, embodying a collaborative, multidisciplinary approach in crafting vessels that cater to scientists' diverse needs. However, a cautionary note emphasizes the importance of avoiding prolonged decision-making to stay ahead of technological advancements. ■

About the author

Wim van Wegen serves as the head of content at *Hydro International*, overseeing both print and online publications for one of the world's foremost hydrography trade media brands. In this role, he not only contributes columns and feature articles but also conducts interviews with renowned experts in the sector.

How data used primarily for navigation can help decarbonize the maritime industry

Steering shipping towards a sustainable future

By Charlie Fardon, head of sustainability, UK Hydrographic Office

Ocean data has a vital but underappreciated role to play as an enabler in shipping's energy transition. In particular, it can help to unlock the short-term carbon savings that will be essential between now and 2030 to keep the industry on track with its longer-term decarbonization ambitions. From green shipping corridors to just-in-time port arrivals, the UKHO is playing a leading role in several sustainability projects and initiatives that are highlighting the importance of hydrography and marine geospatial information.

Transitioning away from fossil fuels to more sustainable energy sources is the biggest challenge facing shipping, an industry that accounts for 3% of global emissions annually and transports 90% of the world's goods. Several measures to help achieve this goal have been earmarked, including alternative fuels, more energy-efficient vessels and digital technologies. However, the conundrum facing shipping's decision makers is how to turn these ideas into reality. One underappreciated asset in this fight is ocean data. This data, which is primarily used for navigational purposes, can help steer shipping towards a more sustainable future. What's more, it can deliver the short-term carbon savings that are urgently required by shipping – and the planet.

Data has long been integral to powering the navigational tools that support safe, compliant ship operations. It now has a major role to play in maritime's energy transition, which

▲ *Data-led solutions can help ease congestion at busy ports such as Hong Kong.*

▲ *Just-in-time arrivals could unlock an 11% fuel and emissions saving for shipping in the near term.*

promises to radically transform the sector's vessels, voyages, fuels, routes and trades. Marine geospatial data is significant because it can provide owners and mariners with an authoritative view of the world around them. Previously, this view has been mainly focused on hazards, depths and other issues associated with navigating in the marine environment. Today, that same information can be used to ensure just-in-time arrivals, underpin the effectiveness and safety of green shipping corridors and support voyage optimization, turning the view of the world around them into an actionable foundation for better decision-making.

The potential impact of these initiatives is significant. For example, just-in-time arrivals, which would be partly powered by navigational data in a more connected marine data ecosystem, could unlock an 11% fuel and emissions saving for shipping in the near term, according to the International Maritime Organization (IMO).

Voyage optimization

Advancements in ship design, fuel efficiency innovations and voyage optimization techniques are already having a tangible positive impact. However, these initiatives alone will not completely decarbonize the shipping industry. To enable the transition towards voyage optimization, reliable and timely data is critical. In support of the collaborative effort to reduce fuel consumption and emissions, shipowners and mariners need the latest information to be able to effectively monitor their activities, optimize their performance and make informed decisions. To this end, high-quality, interoperable and standardized data will be key.

The next generation of navigational data products, underpinned by the International Hydrographic Organization's S-100 data standards, can play a major role in supporting the industry's decarbonization ambitions. The data standards provide a set of guidelines that define how nautical information is structured, encoded and exchanged between systems. They are intended to provide a common framework for the exchange of marine data, making it easier for organizations to share a wide range of information types, including nautical charts, bathymetric data, surface currents, water levels and more.

Armed with more granular and timely data on the ocean environment and its conditions, this will provide the basis for more efficient decisions around navigation, cargo loading and entering or leaving ports. The resulting operational efficiencies can not only provide economic benefit for shipping companies, but crucially can help to reduce emissions through innovative measures such as just-in-time arrivals.

Just-in-time arrivals

The current process of making a port call is inefficient, with ships rushing to their destination only to find that they cannot dock for various reasons, such as another vessel occupying the berth or cargo not being available. This results in ships having to idle outside the port for long periods or move exceedingly slowly while waiting for the availability of the necessary services.

Adopting the just-in-time arrivals approach could yield significant benefits, such as improved safety, reduced emissions, cost savings and better planning capacity. Just-in-time arrivals would enable a ship to adjust and optimize its speed during its voyage, reducing greenhouse gas emissions from sailing faster than required and from potentially waiting to enter port – reducing the environmental and economic inefficiencies of 'sail fast then wait'.

Green shipping corridors

Green shipping corridors – a route between two or more ports where zero-emission shipping solutions are demonstrated and reported – have been identified as a key component to achieving a target of 5%

▲ *Green shipping corridors are key to helping decarbonize the maritime industry.*

About the author

Charlie Fardon is the head of sustainability at the UK Hydrographic Office. She is a highly experienced sustainability professional with an MSc in Global Sustainability Solutions and an MBA from the University of Exeter. Fardon is also Chair of the Natural Environment Research Council's Future Leaders Council.

of vessels operating on zero-emission fuels by 2030. With the sector emitting around 3% of all global greenhouse emissions, accounting for up to one billion metric tonnes of CO2 emissions annually, intervention is critical to reduce maritime's carbon footprint – and to keep the industry on the right trajectory to achieve the IMO's target of cutting emissions at least in half by 2050.

The catalyst for driving change is to create an environment that facilitates cross-sector partnerships, helping to drive policy change, generate innovation and stimulate the next phase of developments. However, private operators and public authorities are likely to find it difficult and costly to deviate from today's norm. Therefore, collaboration is needed between all stakeholders across the entire shipping value chain for this to be achieved. These stakeholders include governments and regulatory authorities, port and ship operators, freight companies, fuel producers, cargo owners and local communities living near or around ports. Their input is necessary to develop new regulations, contracts, policies and facilities to enable the safe operation of green fuels.

A green corridor, which can operate domestically, short-sea or across continents and multiple ports, is a carefully designed ecosystem of change factors, similar to a special economic zone. These factors include port and ship technology, fuel usage and voyage optimization. Building such a corridor requires the advancement of technological, commercial or regulatory initiatives along the route. To succeed, green routes are optimized through the combined efforts of private operators and public authorities. Public investment, extension of fossil fuel subsidies to zero-emission fuels, and targeted policies that introduce best practice guidelines all help incentivize the adoption of new technologies and our shared decarbonization goals.

Green shipping corridors will be key to helping decarbonize the shipping industry, bringing benefits to a wide range of stakeholders, from ship and port operators to consumers and local communities. These include crucial environmental benefits such as increased biodiversity and a cleaner marine environment, as well as economic savings from reduced running costs and shorter anchorage times. These benefits can be achieved by using technology and automation.

UKHO-supported sustainability initiatives

Shifting to sustainable shipping will require collaboration between governments, companies, technology providers and other stakeholders to ensure that we can continue to trade globally while minimizing the impact on the environment.

The UKHO has several workstreams focused on unlocking the power of marine geospatial data to contribute to maritime decarbonization. It supports the UK Government's work on the concept of green shipping corridors, is advancing the development of just-in-time arrivals via multilateral industry coalitions, and is a partner in the exciting 'Blue Visby' project.

Blue Visby Solution

The Blue Visby Solution (BVS) aims to address the 'sail fast then wait' approach by introducing a far more efficient queuing system for ships bound to the same destination port. This system involves synchronizing and optimizing the ocean passages of a group of vessels, allocating optimized arrival times and ensuring an arrival frequency that the port can handle. The project is operated by a consortium of companies and organizations that work together to test and refine the solution. As a consortium member, the UKHO has contributed to the BVS by conceptualizing the Blue Visby 'Blue Box' – a feature determining the start and end point of an optimized BVS.

Using its marine geospatial data and expertise, the UKHO has helped develop a proof-of-concept methodology to understand how these Blue Boxes could be identified and charted. This would enable a vessel to approach a port from any direction, rather than specifically having to plan a route through a specified Blue Box, reducing risk to crew and vessels.

Global Maritime Forum

The Global Maritime Forum (GMF) is an international not-for-profit organization committed to shaping the future of global seaborne trade to increase sustainable long-term economic development and human well-being. The forum brings together leaders from all parts of the maritime industry, from regulators and policymakers to intergovernmental institutions and academia, to address the most important issues that the industry is facing.

▲ *Using granular and timely data on the ocean environment, seafarers can make more efficient cargo loading decisions.*

▲ *Mariners need access to the latest data to make decisions that help to reduce fuel consumption and emissions.*

As a knowledge partner on the GMF Short-Term Actions Taskforce, the UKHO offers its hydrographic expertise to contribute to key research and insight pieces that will help unlock the potential of operational efficiencies and the fuel and carbon savings that come with them.

Smart Maritime Network

The Smart Maritime Network (SMN) provides a platform to share data and improve collaboration among stakeholders in the maritime and transport logistics sectors. This is achieved through the sharing of key industry news, interviews, white papers, presentations and conferences on maritime innovation.

The UKHO is a member of the Smart Maritime Council, which brings together representatives from a range of companies to build partnerships and discuss issues related to compatibility, standardization and harmonization. UKHO representatives regularly meet with other industry stakeholders within the SMN to offer expertise on hydrography, maritime navigation and data sharing to help achieve the network's shared goals.

▲ *Ships often have to idle outside ports for long periods after rushing to their destination.*

With a growing number of sustainability projects and initiatives supported by geospatial data underway and making tangible progress, there is room for optimism about making shipping cleaner and greener in the coming years. Marine geospatial data has a fundamental role to play, both in achieving shipping's short-term carbon savings and in keeping us on track for shipping's longer-term energy transition. But the momentum must continue, with stakeholders across the sector having to play their part to reduce maritime's carbon footprint in line with the IMO's decarbonization goals. Steering shipping towards a more sustainable future is possible, providing we adopt a collaborative approach with engagement from all. ■

5 Questions to...
Exail

Navigating hydrographic frontiers: beyond AI and autonomy

In hydrographic surveying, beyond AI and autonomy, satellites redefine data collection, while over-the-horizon autonomous surveying transmits real-time data. Advancements like cutting-edge sonars enhance ocean observation. Cost-effective USVs signal a paradigm shift. Hydrographers now embrace data management and AI. Exail prioritizes energy efficiency with innovative designs. CortiX integrates real-time data and AI, boosting survey efficiency. The industry's future sees collaborative, open architecture platforms enabling concurrent operation. For deeper insights into these developments, explore Exail's vision in this Q&A – a glimpse into the (near) future!

What do you regard as the current most striking advancements in the hydrographic sector, other than AI and autonomous, when it comes to surveying and data collection?

Cost-efficient large-scale data acquisition and processing have always been a challenge for hydrography. The last few years have been marked by several major developments. The first underlying trend concerns the evolution of data collection and processing methods, with satellites at the forefront of this. Satellite data collection has made tremendous strides in recent years. The sensors that they are equipped with, along with associated image processing techniques, make it possible to obtain very interesting data for bathymetry or the study of shallow water depths. Sonars have evolved in parallel, offering a better resolution. This is a field in which Exail has contributed, by developing cutting-edge sonars for the water column and seabed mapping.

The second noteworthy development is the emergence of more robust over-the-horizon autonomous surveying, thanks to highly reliable and high-bandwidth communication means and highly endurant offshore-going autonomous platforms. These platforms are now able to collect vast amounts of data and, more importantly, transmit them in real time to processing centres located thousands of kilometres away. Among these efficient means of transmission are satellite communication systems. Thus, the commissioning and widespread use of commercial constellations such as Starlink represents a major evolution, as it makes it possible for sensors deployed at sea or in space to easily transmit very large amounts of data at any time.

Another significant advancement is the emergence of new-generation subsea acoustic modems capable of transmitting large amounts of data. We believe they will expand the scope of mother ships and AUV and USV applications, enhancing ocean observation and monitoring.

The rapid progression towards autonomous and remote mapping is quite evident. Could you elaborate on the impact of autonomous vehicles in hydrographic surveying and how they have revolutionized the industry?

The emergence of autonomous vehicles in hydrographic surveying represents a fundamental shift in paradigm. USVs offer a cost-effective alternative to crewed vessels, ensuring sustained operations in challenging conditions. These platforms are by essence smaller and lighter than their crewed counterparts and therefore require less energy to perform their missions, which translates into a reduced environmental signature.

Another parameter to consider is cost-effectiveness. The maintenance costs of autonomous craft are in the order of 5–10% of those of a crewed vessel. We are convinced that the advantages of uncrewed platforms in terms of versatility and operating and maintenance costs will enable smaller companies and countries with limited budgets to operate cutting-edge, high-quality and efficient data collection platforms.

As technology and operating concepts evolve, so do the professions of hydrographer and survey engineer. After considering new technologies such as GNSS positioning or multibeam echosounders, future hydrographers will have to add new skills such as data management or AI to meet the growing needs of the industry.

What are the challenges and solutions related to the power supply and energy management of autonomous surveying vehicles, particularly for long-duration missions?

Energy efficiency is a primary focus at Exail, to minimize fuel consumption and significantly reduce the environmental footprint.

During the design phase of an autonomous vehicle, we pay particular attention to the design of the hull to reduce energy consumption and maximize mission duration, while ensuring exceptional seakeeping capabilities in demanding weather conditions. Take the diesel-powered DriX USV for example. Our return on experience demonstrates that its fuel consumption is 100 times lower than that of a traditional crewed ship with similar mission goals. The reliability of power generation is equally critical, necessitating a robust level of redundancy and smart software-driven power management.

At Exail, we also consider emerging trends in power production such as Li batteries and hydrogen and fuel cells. However, given the current state of technology, these alternative solutions do not meet our expectations in terms of overall efficiency. Last but not least, from a purely system-design perspective, digitization is essential when designing a reliable high-performance autonomous vehicle. A native digital architecture significantly enhances the monitoring capabilities of the vessel's structure and key systems throughout long-duration missions.

What is your view on the integration of real-time data and AI-aided and/or autonomous decision-making in hydrographic surveying operations?

The integration of real-time data and AI marks the start of a significant journey. Exail's DriX USV, for instance, relies on an advanced software autonomy package known as CortiX, which facilitates reactive, data-driven autonomous behaviour. A recent addition to its capabilities is the market-leading autoline function, designed to elevate survey efficiency. The autoline dynamically adjusts the DriX trajectory between survey lines to optimize overlap requirements, alleviating cognitive burden on surveyors and mitigating the risk of gaps in data.

For navigation purposes, CortiX relies today on the S57 Electronic Navigation Charts. In the future, the implementation of the S100 format will unlock new capabilities for contextual and environment-driven navigation, thereby enhancing operational safety and efficiency.

A discernible trend in autonomy is a progression towards higher-level autonomy goals. In the realm of hydrographic surveying, this shift entails transitioning from deterministic survey line plans to more sophisticated multi-objective optimization strategies. These advanced strategies encompass a comprehensive approach that considers not only survey goals but also prioritizes operational efficiency and safety.

▲ *DriX USV operating on a wind farm. (Image courtesy: Exail)*

What trends and future developments do you foresee when it comes to remote and autonomous hydrographic surveying and AI, and how will they shape the industry?

Exail is a firm advocate of the concurrent remote operation of multiple vehicles, seamlessly combining USVs, ROVs, AUVs and ROTVs. This approach is geared towards optimizing efficiency and accommodating a diverse range of concepts of operations (CONOPS). Whether applied to hydrographic surveys, wind farm inspections or scientific endeavours, there is a growing demand for the simultaneous operation of multiple uncrewed systems, each dedicated to a specific task.

Successfully realizing this vision requires a collaborative mindset among technology providers, working together to achieve the end goals of customers. Exail actively contributes to this collaborative landscape by developing open architecture USV platforms and boasting a commendable track record of cooperative efforts with various industry players. ■

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The kick-off of a vital discussion

Surveying and sustainability

By Gordon Johnston, Venture Geomatics, UK

While sustainability may not be the most exciting topic for some, it is becoming ever more important. Sustainability is the goal of carrying out our normal day-to-day activities without consuming single-use products or depleting our natural resources. This means that everything that we use should be replaced, such as wood by planting forests. Or, as the United Nations Brundtland Commission defined in 1987: sustainability is "meeting the needs of the present without compromising the ability of future generations to meet their own needs."

▲ *The renowned Blue Marble photograph, taken by the Apollo 17 crew on 7 December 1972, offers a captivating perspective of Earth from a distance of approximately 29,000km during their journey to the moon. This iconic image highlights Africa, Antarctica and the Arabian Peninsula. Fast-forwarding five decades, a concerning reality emerges – global temperatures have significantly risen.*

The harsh reality is that this means removing our dependence on hydrocarbon fossil fuels and rare earth minerals for batteries, and moving towards net zero emissions of carbon dioxide, the most prevalent of the greenhouse gases. As surveyors, we often work in areas that are about to be developed, or further developed, and it is our data that informs on the current natural and built environment and its state and condition. It is not our role to determine the merits and the rights and wrongs of the development. However, controversial projects such as deep-sea mining for manganese nodules, open-cast coal mining and the drilling and development of oil and gas resources may prompt us to decide whether we are able and willing to support such enterprises. Although we can of course simply choose not to tender for work that we feel would be detrimental to ourselves and the environment, we may also choose to use the most up to date methods and efficient technologies. We can use systems to generate the best possible datasets that minimize the potential impact of any development. These datasets can be designed to inform the developers and help avoid poor design and inefficiencies and reduce waste. Good data will also hopefully help minimize the carbon footprint. We therefore have a role to play, from the first tendering steps to a wider impact throughout the life of the development.

▲ *Logo of COP28, the 2023 United Nations Climate Change Conference held in Dubai in late November and the first two weeks of December of that year.*

The recent COP28 event in Dubai highlighted several areas where we as a society are having to take action, make decisions that reduce the impact of our actions on our planet, and balance these with competing pressures across the world. Transparency and reporting are increasingly expected and are becoming more demanding in terms of the elements related to environmental, social and governance (ESG) commitments. ESG criteria are used to assess

We can, through our profession, encourage organizations to gain B Corp Certification and avoid greenwashing and lead and influence the projects of the future

how well a company is managing its impact on the environment and society and its internal governance. Developers, operators and owners of infrastructure are also having to report on the levels of carbon produced and embedded in projects and the completed development. This mandatory carbon reporting (see https://www.carbonfootprint.com/mandatorycarbonreporting.html) affects many stakeholders, including investment and pension funds with infrastructure, energy, telecommunications and other developments in their portfolios.

Investors therefore increasingly consider ESG factors as part of their investment strategies. They believe that companies with strong ESG practices are better positioned for long-term success, as they are likely to be more resilient in the face of environmental and social challenges. Moreover, consumers and other stakeholders are becoming more conscious of the social and environmental impacts of their choices, influencing companies to adopt sustainable and responsible practices.

Even if much of this is currently aimed at large listed corporations and high value development projects, this also affects us, as surveyors are in many ways at the forefront of such developments.

We therefore need to improve our current levels of reporting and influence good sustainable practices. As reporting systems develop, ESG parameters will become more prominent, and we already see invitations to tender with questions on ESG. However, no authoritative guidance, advice or good practices are yet offered to assist clients or contractors in setting, answering and evaluating questions and their responses.

Of course, we want to use the most up to date methods and most efficient technologies and systems, and collecting data now benefits from various technological advances that give the impression that we are reducing our collective impact on the environment. However, this is not the full story and we should recognize that our use of drones, robotics, remotely controlled and uncrewed platforms and scanning technologies all rely upon rare earth metals and materials and have produced a carbon footprint in their development, design and manufacture. Our operations are also likely to have some impact: cloud-based computing and the use of uncrewed surface vessels are reducing our carbon footprint, but the transfer of data via satellites and the creation of huge data lakes may increase it.

Behaviours and social norms are therefore changing and developing. The next generation workforce will probably not invest in fossil fuels but choose more sustainable options. So, what do we as individual professional surveyors need to do now? What can we do, should we do, must we do? As Howard Zinn said: “Small acts, when multiplied by millions of people, can transform the world.” For many surveyors, this will mean small adjustments to behaviours and everyday tasks and jobs. However, as experts in spatial data, we must review our metadata formats to include carbon footprint parameters and provide guidance on this. Furthermore, data should adhere to FAIR principles wherever possible (see the FAIR Guiding Principles for scientific data management and stewardship 2016, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4792175/), within an agreed time frame to lessen the need for future works. This too will probably affect us.

Working with the International Federation of Surveyors (FIG) and the Royal Institution of Chartered Surveyors (RICS) in the UK, the intention is to develop guidance and advice and provide thought leadership on sustainability in our profession. Initial steps have

▲ *As spatial data experts, let’s refine our metadata formats to embrace carbon footprint parameters and offer nuanced guidance on this matter.*

begun within the FIG Commission 4 – Hydrography work group with support from RICS. However, this effort will benefit from a wider collaboration so that good practices can be identified, promoted and operationalized. We can, through our profession, encourage organizations to gain B Corp Certification and avoid greenwashing and lead and influence the projects of the future. If we do not, the current optimistic requirements for the collection of spatial data may be challenged by other disruptive technologies and solution providers, and this will also affect us!

In summary, sustainability is increasingly vital for surveyors and is guiding efforts to reduce our dependence on fossil fuels and to address the carbon footprint of emerging technologies. COP28 emphasized the global push for transparency and adherence to ESG criteria, positioning surveyors as leaders in this transformative shift. As stakeholders prioritize sustainability, surveyors must enhance reporting standards and champion eco-friendly practices, shaping a key role in a sustainable future. Collaborative efforts through organizations provide guidance, advice and thought leadership, ensuring that the profession actively contributes to a greener world. *Hydro International* is undoubtedly one of the leading platforms to shape this discussion and stage the debate. I would therefore welcome seeing sustainability serve as the foundation for a growing number of articles and columns in this magazine and other media channels. ■

About the author

Gordon Johnston is a seasoned surveying professional with over 25 years in the industry, specializing in offshore and hydrographic surveying. Based in the UK, Gordon has been a director at Venture Geomatics since 2006. As a RICS Chartered Surveyor, he is an ex chair of the RICS Global Geomatics Professional Board and currently sits on the RICS Governing Council. He also served as the head of the UK delegation to FIG, representing Commission 4 – Hydrography. Actively engaged in international standards, Gordon Johnston is a member of the International Board for the Standards of Competence of Hydrographic Surveyors and Nautical Cartographers (IBSC). He has contributed significantly to the field, with numerous published papers on offshore survey-related topics.

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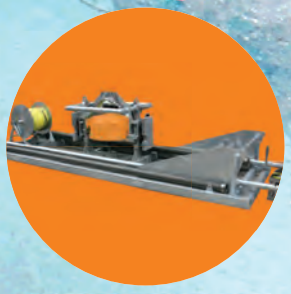

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NORBIT Subsea

NORBIT develops and manufactures wideband sonar systems for applications in the hydrographic, security, energy and dredging markets. With strong service and support capabilities, the global organization has pioneered the development of integrated multi-sensor and ultra-high-resolution multibeam systems.

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Nortek

Nortek designs, develops and produces scientific instruments that apply the Doppler principle to underwater acoustics to measure movement under water. This includes measuring processes such as currents and waves and helping subsea vehicles to navigate.

Nortek's scientific product portfolio, primarily acoustic Doppler current profilers, is capable of measuring everything from small-scale turbulence to full-ocean current profiles. Its navigational aids – Doppler velocity logs – bring vehicles safely and reliably to great depths under challenging conditions.

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The low weight and compact design of the VQ-840-G and VQ-840-GL allow for integration on smaller aircraft and UAVs – ideal for detailed data acquisition in smaller-scale applications at shorter intervals, such as coastal erosion monitoring or the surveying of port infrastructure or rivers at risk of flooding.

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Woolpert

Woolpert's certified hydrographers, land surveyors and GIS professionals develop and integrate topographic, bathymetric and hydrographic technologies to provide the data, analyses and modelling needed to advance critical projects and initiatives. Woolpert's full-service geospatial capabilities complement its expansive maritime services, which include elevation-derived hydrography, dredging and marine construction support, seafloor mapping, emergency response, reservoir capacity, tidal and river current survey, tidal gauge analyses, cable and pipeline alignment, geodetic and geophysical survey, environmental mapping and remediation, marine GIS, object detection and more. Owning and operating fleets of survey vessels and manned and unmanned aircraft, Woolpert enables immediate and proficient mobilization. This responsive structure and leadership support the expert collection of high-accuracy topographic and bathymetric Lidar, multibeam and sidescan sonar data and high-resolution imagery, as required by public, private and governmental agencies around the world.

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Redesigning surveying to support a sustainable global future

The role of surveyors in building climate resilience

By Roshni Sharma and Clarissa Augustinus, co-chairs of the International Federation of Surveyors Climate Compass Task Force

New knowledge and tools are needed if surveyors are to fulfil their critical role along the path to achieving humanity's global climate goals related to land, water and the marine environment. Surveying systems must also be redesigned in several respects: shifting focus from data collection to analysis, integrating geospatial and climate data, designing for climate resilience and for infrastructure, and collaborative solutions.

By 2030, the world is projected to experience significant changes as a result of climate change. Coastal areas will face increasing threats from rising sea levels, leading to the erosion of shorelines and increased flooding during storms. Low-lying coastal cities and island nations are particularly vulnerable, displacing communities and threatening critical infrastructure. Hurricanes, droughts, heatwaves and wildfires will continue and accelerate in frequency, and lead to increased risks to human health and safety. The poor in the Global South will continue to experience the greatest impact, even though they contribute the least to the problem because of their tiny carbon footprints.

Changing weather patterns will disrupt agriculture systems, and crop yields will decrease due to shifting climate conditions, land degradation and desertification. Water scarcity will continue to increase. Biodiversity loss will accelerate. This will all impact on food security and will lead to increased human migration, both within countries and across borders. Surveying and geospatial professionals play a key role in understanding and mitigating these and other impacts of human-induced climate change.

Shifting focus: from data collection to analysis

The geospatial and surveying industry is undergoing a profound transformation, shifting from its traditional emphasis on data collection – which remains fundamental – to an additional new focus on data analysis. Analysing geospatial data is crucial in unravelling the multifaceted impacts of climate change and land degradation. It enables the extraction of meaningful insights from trends, patterns and anomalies in the data, allowing for a deeper understanding of human-induced climate impacts on countries, regions, landscapes, ecosystems and communities, and facilitating data-driven decision-making.

This industry shift signifies a broader recognition of the value of data analysis in climate resilience efforts. It empowers surveying professionals to both collect data and interpret it, ultimately contributing to more effective and evidence-based climate adaptation and mitigation measures. By morphing into specialized data analysts, surveyors will bring an indispensable skillset to the forefront of the fight against climate change.

Integrating geospatial and climate data for comprehensive analysis

Climate change operates on multiple scales and dimensions – at local, national, regional and the Earth system level. Analysing geospatial data from a diverse array of sources is paramount in comprehending the multifaceted impacts of climate change. It is vital to assess land use changes, track temperature fluctuations, and monitor sea-level rise, changes in forest edges, global food production and unregulated large-scale acquisitions of land belonging to Indigenous peoples and local communities. Geospatial data, collected through satellite

▲ *Small island nations, especially in the Pacific, are already feeling the impacts of rising sea levels impacting land ownership and tenure security.*

▲ *Today, remote sensing is invaluable for measuring and monitoring the majority of climatic indicators.*

imagery, ground-based surveys and remote sensing technologies, provides a comprehensive view of these complex changes.

Scenario simulations, particularly digital twins, can revolutionize decision-making in climate resilience. These models are able to simulate various climate-related scenarios, providing insights into potential vulnerabilities and necessary adaptations. Digital twins enable proactive planning and management and can protect people and the planet from the escalating impacts of climate change.

Redesigning land and water systems for climate action

Climate change, land degradation and desertification are triggering a significant transformation in land use across the globe, redefining agricultural zones, urban planning and natural resource management. These shifts represent some of the most visible and pressing impacts of the changing climate. Geospatial data is a critical enabling factor in adapting to, mitigating and optimizing land use changes, including to enhance food and water security and to protect biodiversity and natural areas in a changing world.

Most natural capital (e.g. forests, grasslands, natural areas) is in the form of common property, which is generally held in some form of state or public land arrangement. Often these parcels are not documented in government land systems. Fit-for-purpose boundary demarcation is essential to manage the resources in these areas efficiently and to safeguard what climate scientists call 'protected areas', such as game parks and forests. Land administration systems as a whole need to be made fit for purpose, efficient and effective to enable the rapid implementation and rollout of security of tenure for the achievement of global climate goals. Without land tenure security, people will continue to 'mine' their resources rather than maintain them. Valuers would argue that establishing property rights and pricing nature's benefits correctly can be an effective approach to maintaining and restoring natural capital. Fit-for-purpose land valuation approaches that include natural capital need to be developed and scaled up.

Ethical and legal dimensions

Geospatial data can contribute to smarter spatial planning to reduce the footprint of agriculture, limit urban sprawl and strengthen spatial planning targeting to protect biodiversity. The ethical and legal dimensions of urban planning take centre stage, as governments grapple with issues like competition over land and property rights, management of informal settlements and flood management.

The shifting landscape of natural resource management necessitates tracking and monitoring, with geospatial data providing real-time insights into land use changes. It can support land governance and the protection of local communities' rights to land and natural resources. It is also vital to help governments protect natural areas such as forests from illegal logging, game parks from cattle incursions, and water towers from human activity. Geospatial data-driven natural resource management underpins ethical and responsible resource extraction and habitat preservation in accordance with the legal aspects of environmental regulations and international treaties.

Marine environments

Climate change is having a major impact on marine environments, fundamentally altering the delicate balance of life beneath the waves. Coastal ecosystems – from mangrove forests to coral reef – are under immense stress. Surveying and geospatial technologies are indispensable tools in monitoring and managing the changes. High-resolution mapping and remote sensing enables scientists and conservationists to track shoreline shifts, assess the health of coral reefs and safeguard marine resources. This also enables the monitoring and enforcement of marine regulations aimed at preserving biodiversity and critical habitats.

Resilient infrastructure

Climate change poses multifaceted challenges to critical infrastructure, spanning transportation, energy and water supply systems. Rising temperatures intensify wear and tear on roads and bridges, while extreme weather events disrupt transportation networks. Energy infrastructure faces increased demand due to climate-induced heatwaves, while water supply systems grapple with shifting precipitation patterns and the threat of prolonged droughts.

Surveying and geospatial expertise stands as a crucial pillar in crafting resilient infrastructure design and adaptation strategies. Surveyors play a pivotal role in collecting precise geospatial data, enabling informed decisions about climate-resilient infrastructure placements and designs. Geospatial insights are essential for identifying vulnerable areas and optimizing resource allocation for climate adaptation. Moreover, community engagement is pivotal in

About the authors

Roshni Sharma

Roshni Sharma, co-chair of the Climate Compass Task Force with the International Federation of Surveyors (FIG) and a leader at FrontierSI, focuses on leveraging location intelligence for positive societal change. She plays a key role in bringing cutting-edge geospatial innovations to academia, industry, and government, and is involved in various leadership roles, including as a director for the Geospatial Council of Australia (GCA).

Clarissa Augustinus

Clarissa Augustinus, co-coordinator and co-editor of the second edition of the United Nations Convention to Combat Desertification Global Land Outlook, is an honorary ambassador for the International Federation of Surveyors (FIG). With a background at UN-Habitat and a PhD in Social Anthropology from Rhodes University, she brings extensive expertise in land-related initiatives, urban legislation, and governance.

ensuring that infrastructure projects align with local needs, values and long-term sustainability goals, and surveyors often have a unique relationship with local communities.

Collaborative solutions

Successful collaborations between surveying professionals, climate scientists and policymakers have emerged as a potent force in addressing the multifaceted challenges of climate change. Surveying professionals provide essential geospatial data and analysis, offering a comprehensive understanding of climate impacts on land, water, marine and infrastructure environments. Climate scientists and environmental scientists bring their specialized knowledge, conducting research to predict and assess changes in the climate and human-induced environmental impacts. Policymakers translate this information into policies, actionable strategies, legislation and resource allocation to mitigate climate risks and avoid or limit degradation and restore the environment. Surveyors then make some of this happen on the ground.

The integration of geospatial and climate data serves as a cornerstone of evidence-based decision-making. Precise mapping, remote sensing and geographic information systems (GIS) enable stakeholders to visualize climate trends and vulnerabilities, facilitating targeted interventions. This data-driven approach enhances the capacity to adapt to climate change by identifying high-risk areas and optimizing resource allocation.

So what can you do?

In an era where our planet faces increasingly complex and unpredictable environmental challenges, surveying brings a vital technical foundation that underpins climate resilience strategies. Precise surveying and geospatial data reveal the changing land use and chart the path toward a more sustainable future. Integrating climate data and geospatial insights into surveying practices and work on the ground is not just a choice; it is an imperative. It is the synergy of these two disciplines that will help our industry maintain and build its relevance, and empower us to work with other sectors to create sustainable solutions.

In a world where climate change poses ever-increasing challenges, it is time for action. Join the movement to safeguard our planet, inform evidence-based decisions and chart a new course towards a sustainable and resilient future for generations to come. Join the FIG Climate Compass Task Force. ■

The original version of this article appeared in *GIM International*, issue 7, 2023.

Further reading

https://fig.net/organisation/tf/climate_compass/index.asp
https://bit.ly/FIG-CC-TF

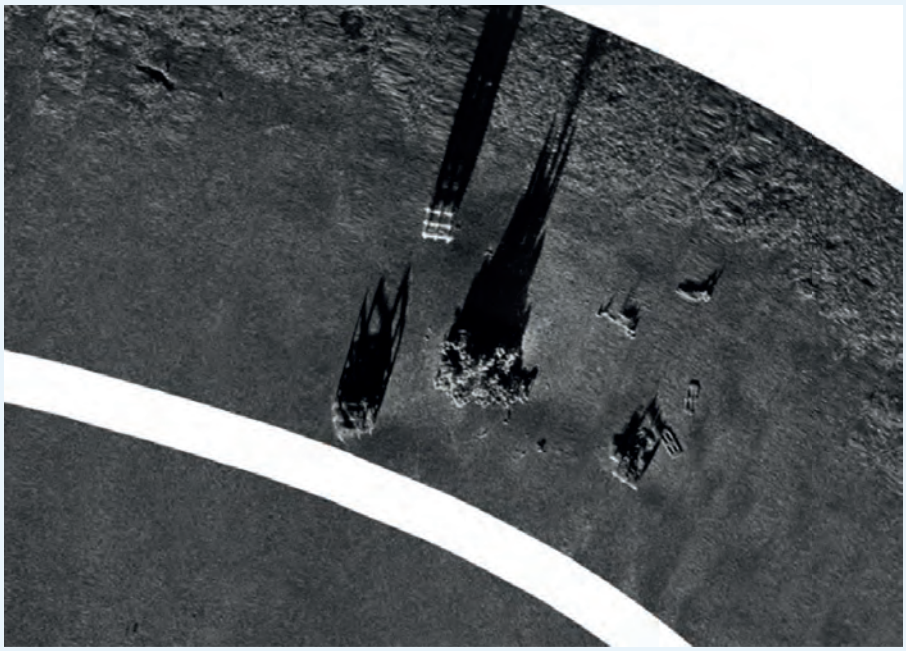
DriX and FlipiX: Exail's smart solution for bathymetric, geophysical and UXO surveys

Combining the DriX uncrewed surface vehicle (USV) and the FlipiX remotely operated towed vehicle (ROTV), Exail has developed a unique solution enabling fully autonomous and remotely operated surveys.

Accurate surveys of the seabed are vital before any infrastructure can be installed in the development of maritime projects such as offshore wind farms, cable laying and pipeline installation. DriX is known for being able to accommodate various payloads in its gondola, located two metres below the surface. However, specific projects require higher resolution with sensors carried closer to the seabed.

Leveraging on many years of experience, Exail designed and tested FlipiX, a brand new ROTV, to meet the needs of the offshore industry. This ROTV is perfectly suited to high-resolution bathymetric, geophysical and unexploded ordnance (UXO) surveys in combination with the DriX autonomous surface vessel. With a length of 1.8m and a width of 2.7m, FlipiX is built entirely of composite material. It is a compact and versatile vehicle with active pitch and roll motion stabilization, and can be towed by a USV or a conventional vessel. With its active motion control, FlipiX is perfectly suited to acquiring best-in-class sidescan sonar data at a very high frequency (850kHz), even in the most demanding conditions.

FlipiX can be operated at fixed altitude or fixed depth, down to 100 metres and as close as one metre from the seabed for optimal measurement quality and resolution. From an operator point of view, FlipiX benefits from Exail's philosophy to design user-friendly human machine interfaces. The ROTV's control software is directly implemented in DriX's human machine interface, a web-based interactive system that allows users to easily and efficiently supervise both DriX and FlipiX from the same access point.



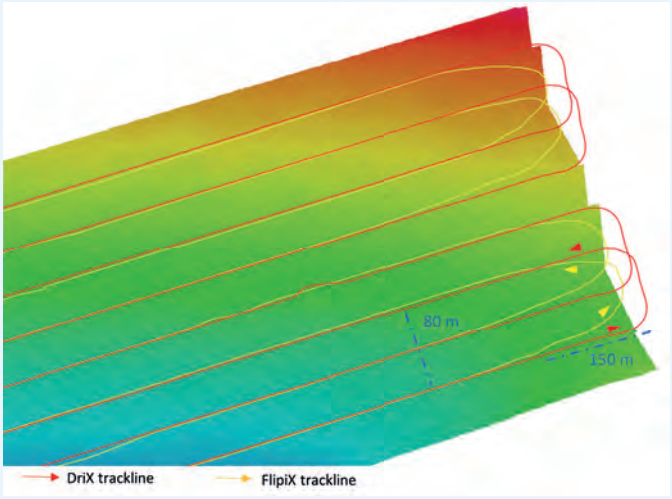
▲ *Figure 1: Very high frequency EdgeTech 4205 sidescan sonar (850kHz), acquired by FlipiX over structures on the seabed.*

From its inception, DriX was designed to be easy to operate, whatever the towing USV's behaviour. Its positive buoyancy is critical for operational safety. During typical survey patterns, if DriX stops then FlipiX slowly moves upward to the surface, rather than sinking to the bottom like a conventional towed heavyweight payload. As soon as DriX resumes its mission, FlipiX moves back to the requested depth/altitude. DriX and FlipiX can also perform sharp-turn manoeuvres between the survey lines. During turns, FlipiX uses its active motion control to follow and stay at the same depth or altitude. FlipiX's enhanced stability in turns has a great effect on the survey efficiency.

In the example below, FlipiX was towed at 50-metre depth behind DriX using a 120-metre cable to carry out UXO operations. The tracks of both vehicles highlight a sharp and quick 160-metre turn performed in under three minutes, including the 150 metres of run-in before FlipiX is aligned, with a five-metre line offtrack tolerance.

DriX and FlipiX, an outstanding combination for multisensor data acquisition

Owing to an open architecture, DriX and FlipiX can accommodate best-in-class payloads for a wide spectrum of missions. An example configuration is the DriX payload gondola fitted with an Exail Phins Compact



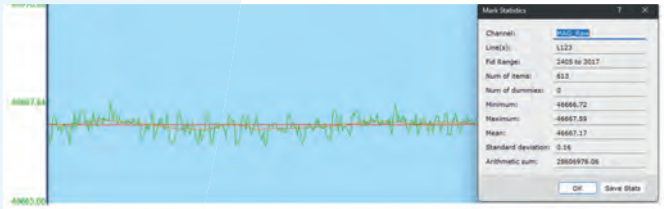
▲ *Figure 2: DriX and FlipiX tracks during a UXO survey line change.*

C7 inertial navigation system, a multibeam echosounder, an Exail Echoes T1 sub-bottom profiler and an Exail Gaps M5 USBL system.

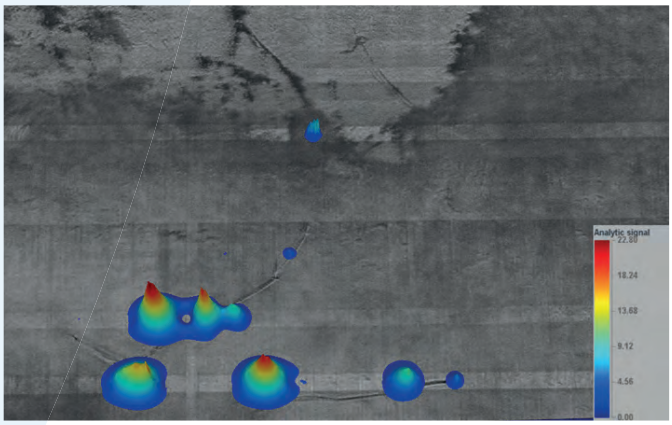
FlipiX is equipped with an EdgeTech 4205 sidescan sonar, a reference in the industry, allowing best-in-class sonar data acquisition up to a frequency of 850kHz. The sidescan sonar provides remarkable imagery data of the seafloor, allowing the inspection of structures, the identification of potential UXO, and seabed and habitat classification. A G882 Caesium Vapour magnetometer from Geometrics was towed 1.5m behind FlipiX. The G882 is a reference for UXO detection projects, being specified for its resolution and detection capabilities. Thanks to its composite material structure and hull, FlipiX provides a low-noise environment. All configurations have shown a maximum of 0.5 nanotesla noise amplitude, meeting the industry requirements for UXO surveys.

Combining DriX and FlipiX provides high-resolution seabed mapping in a single line at five to six knots, encompassing multibeam, sub-bottom, sidescan sonar and magnetometer data

A Valeport miniSVS fitted with a pressure sensor allows FlipiX to collect sound velocity profiles during the ROTV's dive from the surface to the seabed. FlipiX's real-time underwater position is tracked by an Exail MT9 transponder. The accurate positioning of FlipiX performed by the Gaps USBL and the MT9 beacon allows a direct comparison of the data. This comparison is crucial, especially for UXO surveys, as the combined analysis of MBES, sidescan and magnetometer data makes it possible to determine the anthropic nature of targets found on the seafloor.



▲ *Figure 3: FlipiX-towed G882 magnetic field during UXO survey.*



▲ *Figure 4: combined results of magnetometer and sidescan sonar data.*

One of the main advantages of using DriX and FlipiX together for customers is that the two vehicles provide high-resolution seabed mapping capabilities sailing in a single line at five to six knots and combining multibeam, sub-bottom, sidescan sonar and magnetometer data.

The image above shows the combined results of the sidescan imagery (black and white image) and the 3D representation of the magnetic anomalies (blue to red colours), highlighting the anchor positions of an anchor chain line placed on the seabed.

The use of DriX and FlipiX is the first commercial-grade autonomous solution combining such a comprehensive set of measurements. Exail has also developed a light launch and recovery system that can be installed on RHIBs or small vessels. DriX is designed to be operated over-the-horizon using either 4G or satellite communications, and the availability of high-bandwidth satellite communications such as Starlink is considered a real game-changer in remote survey operations. Data QA/QC can be conducted remotely during the survey, reducing personnel on-site and enhancing operational efficiency. DriX and FlipiX are configured as a standalone integrated package, and all data acquired by FlipiX is recorded in DriX's survey PC, together with the multibeam, sub-bottom and USBL data. This provides the hydrographic surveyor with an overview of all data in the same hydrographic environment.

Using this combined system, a significant part of the operation planning and preparation (sensor installation, equipment configuration, etc.) can be done ahead of mobilization. Autonomous solutions for hydrographic surveying are also working towards standardizing the operational workflow and operator training.

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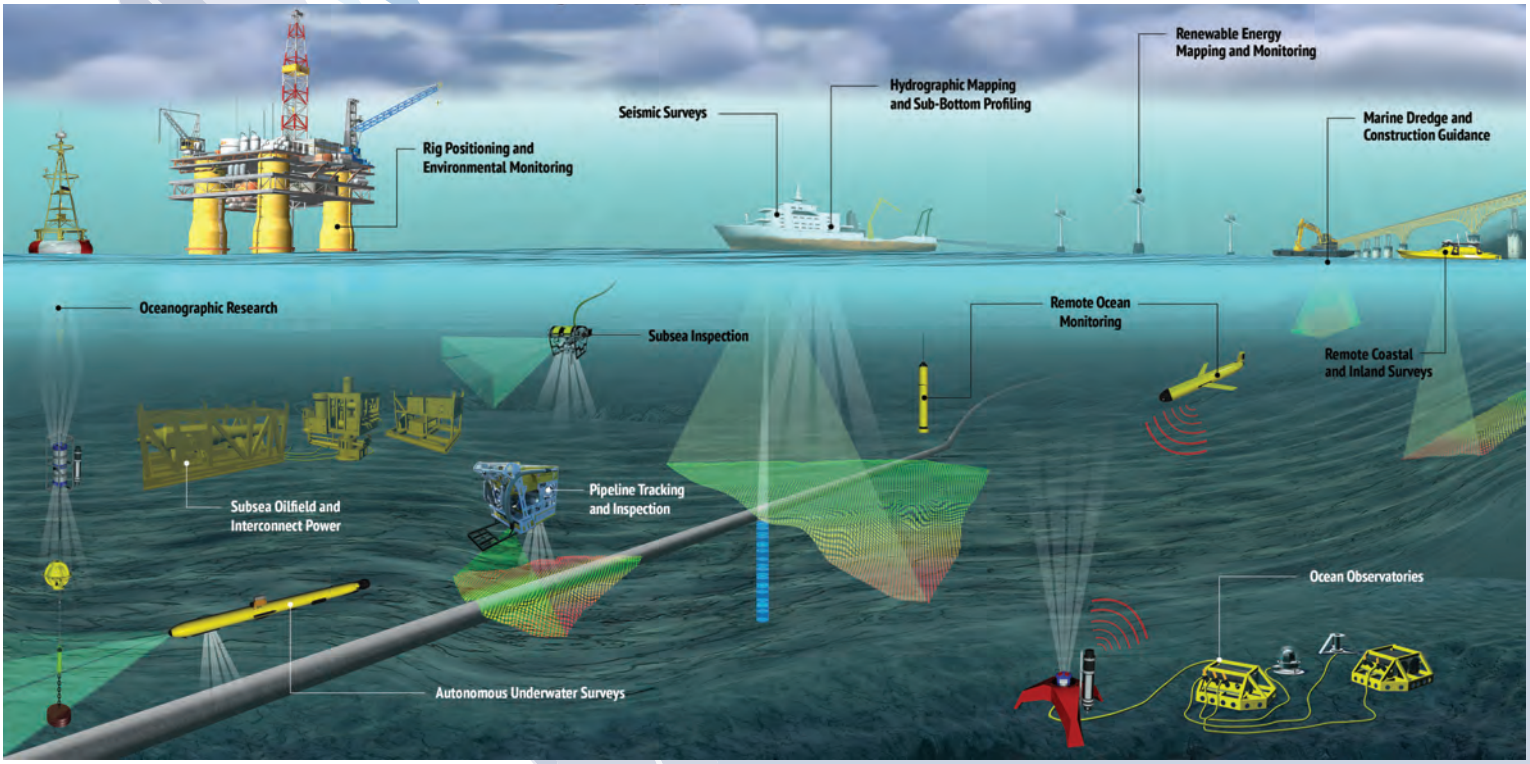

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Interview with Commodore Stewart Dunne

A legacy of success and anticipating trends in maritime surveying

By Wim van Wegen, head of content, Hydro International

Hydro International **took the opportunity to sit down with Commodore Stewart Dunne, reflecting on his role as the former Hydrographer of Australia and highlighting key achievements that include the success of the HydroScheme Industry Partnership Program (HIPP) and enhanced regional collaborations. Looking forward, Dunne envisions significant shifts in hydrographic surveying, emphasizing adaptability and the growing demand for maritime environmental data. He discusses the evolving landscape, considering factors such as climate change, offshore renewables and defence needs. Dunne shares insights into hydrographic certification, technological advancements and the imperative for industry capacity. He also outlines his future involvement in the hydrospatial domain and offers valuable advice for aspiring professionals.**

Your tenure as Hydrographer of Australia has come to an end, presenting a fitting opportunity to reflect. When considering what the Australian Hydrographic Office (AHO) has delivered over the last few years, what achievements come to mind?
Our greatest achievement has been in delivering HIPP. As the name suggests, this is a partnership between the Australian government and industry to deliver a commercial data acquisition programme to meet Australian maritime environmental needs, with the main focus on the data required for navigation safety. The programme is managed through the AHO within the Department of Defence and has proved to be one of the most successful projects run within defence. The other key achievement has been building strong and meaningful relationships with our regional neighbours at the hydrographic office level. A lot of work has been done across the region, but arrangements with India, Indonesia and Fiji have been incredibly rewarding and building on these relationships into the future will be exciting. This has been evidenced through Australia being voted in as Chair of the South West Pacific Hydrographic Commission and greater attendance at regional hydrographic conferences and events.

Looking ahead to 2024, how do you view prospects in the hydrographic surveying industry compared with the past couple of years?
Even in my tenure as Hydrographer of Australia, I have seen tremendous changes – both challenging and providing great opportunity. From a hydrographic office perspective, the move towards the S-100 regime has meant a fundamental shift in the way we do business and our future thinking. I think this has translated into the hydrographic surveying industry in two ways – we must be open to doing our business in more than just traditional ways and the need for maritime environmental data will increase exponentially. Hydrographic surveying is more than just bathymetry. In Australia, the need for qualified and experienced hydrographic surveyors has never been greater. Our challenge is to have those embarking on a new career to understand that becoming a marine surveyor is valued, rewarding and a career for life.

Considering the hydrographic sector as a whole, what technological developments do you anticipate will be the most significant in the coming years?
While autonomous systems have been around and used by the marine survey sector for many years, their use is becoming more varied and wider, and significant technological improvements have taken place; trends that will continue in the future. I think autonomy in the marine environment and the use of AI and machine learning ashore to manage and exploit large volumes of data will be fundamental game-changers. It's not just about the hardware; our practices too will be much influenced as a result. As an example, the use of two DriX autonomous vessels in conjunction with a mothership by Ocean Infinity to conduct survey operations shows what can be done. I do however think that cost factors will continue to shape this into the near future.

About Stewart Dunne

Commodore Stewart Dunne was commissioned into the Royal Australian Navy in August 1990. During his rewarding career, he specialized as a Hydrographic Surveyor and gained experience at sea and ashore in the areas of command, operations, training and capability development and acquisition. He assumed the role of Hydrographer of Australia on promotion to Commodore in December 2020 and is currently transitioning from defence.

Stewart is a Defence and Strategic Studies graduate of the Australian War College and was awarded a Masters of International Relations and a Graduate Certificate in Defence and Security Studies from Deakin University and a Master of Arts (Strategy and Security) from the University of New South Wales. Stewart is recognized as a Royal Australian Navy Charge Surveyor and has achieved the internationally accepted Cat A specialist qualification and been awarded a Graduate Diploma of Hydrographic Surveying from Plymouth University.

How do developments such as climate change, sustainability and the growth of offshore renewables such as offshore wind impact the operations of the hydrographic industry? You might think that the growth of offshore renewables would replace work in sectors such as the oil and gas industry. However, I'm not so sure, and if so, the timelines of phasing out one industry and the phasing in of another will overlap, putting strain on industry capacity; that is, the number and availability of platforms and hydrographic surveyors. I think another area – defence – will also start to impact the hydrographic industry significantly. Defence forces around the world do not have the foundation datasets required to support full operations in the maritime domain or provide the volumes of ingestible data required by future military capabilities. I think industry will be increasingly used to fill this gap, particularly if the requirement to fill this need is accelerated. This too may put strain on the industry; a good problem to have in many respects but one that requires solutions.

As the former Chair of the Australasian Hydrographic Surveyors Certification Panel, can you provide us with an update on the status of hydrographic certification in your region?

As we know, specialist certification in hydrographic surveying is the official recognition that an individual possesses the necessary knowledge to perform hydrographic surveying tasks along with the demonstrated ability to apply that knowledge across various hydrographic disciplines. The professional assessment and certification of hydrographic surveyors is conducted through the Australasian Hydrographic Surveyors Certification Panel (AHSCP) under the auspices of the Geospatial Council of Australia. In the 1980s, the hydrographic surveying industry, professional organizations and users of survey data identified that they needed a regulated supply of competent hydrographic surveyors. This was realized in 1994 with the creation of the first accreditation panel. Through time, this panel has matured into the AHSCP and remains chaired by the Hydrographer of Australia. Demand for certification has increased steadily in recent years and there is a wide acceptance that this is the industry standard to promote best-practice hydrographic surveying.

In what ways can the hydrography sector learn from other industries?

Our industry has been around for a long time but there is still much to learn, particularly if we want to grow and be relevant into the future. I think we suffer from a lack of acknowledgment and understanding within governments, government departments and the broader community of the value we bring to national and global economies and understanding of the marine environment and the effects of climate change. Other industries have a more mature understanding of how to sell themselves and shape and influence policy. In the Australian context, the mining industry for example is far better known and more influential but none of the exported by-products of this industry could leave Australia without a hydrographic industry. As an island, Australia is reliant on the ocean and the hydrographic survey industry facilitates the flow of trade, communications and travel but has little visibility.

You are waving goodbye to your role as Hydrographer of Australia. What are your thoughts on where the AHO is going in the future?
As for many Hydrographic Offices, the transition to S-100 is going to be a focus. This will obviously require an internal change process for business processes and policies but importantly it will also require an education process for our customers and stakeholders. The AHO started planning early and has taken an approach of not rushing to a solution but understanding what fits our business model best.

A critical success factor is recruiting enough people to serve either onboard or ashore. What is your view on this?
Capacity in our industry will be critical going forward and the human element to this will be key. Qualification and experience are fundamental to having a professional industry, but at the end of the day you need people who are available and invested and interested in a career in the hydrospatial discipline. In Australia, we recognized that having a domestic education programme for hydrography was going to be a significant contributor to getting enough and the right people. AMC Search, the training and consultancy division of the Australian Maritime College (AMC), has signed an MOU with Fugro to develop and gain IBSC accreditation for a Cat A Hydrography course to service the Australasian region. The MOU provides a guiding framework for AMC Search and Fugro to combine resources to develop a modern course that will meet the requirements of the IBSC. The aim of this collaboration is to utilize the skills and expertise from each organization to develop a course that will provide the hydrographic survey community with a much-needed training programme that is currently unavailable in the Australasian region. Formal development work will commence in early 2024 with an expected launch date in Q1 2025. The course will be open to people already in the industry or those wanting to commence an exciting and rewarding career in hydrographic survey.

What advice do you have for young people thinking of a hydrographic or oceanographic career?
When you're making your early career choices, understand that a hydrographic or oceanographic career will offer a lifetime of opportunity. It will take you all over the world, you will have access to the latest technologies, and the tasks and activities are wide and varied. Above all, you will be part of a community that is innovative, engaged and interesting. Give it a go!

With your term as Hydrographer of Australia now concluded, we're intrigued to know about your plans for the upcoming years. What do you have in store for the future?
The role of Hydrographer of Australia has given me very good insight into the hydrographic industry and I want to remain involved and add value. My first commitment will be as a member of the Board of the Geospatial Council of Australia. I will also be setting up a small consulting business, hoping to find solutions to industry problems in the hydrospatial domain. ■

Legal frontiers of USVs

Remote hydrography and regulation: mission impossible?

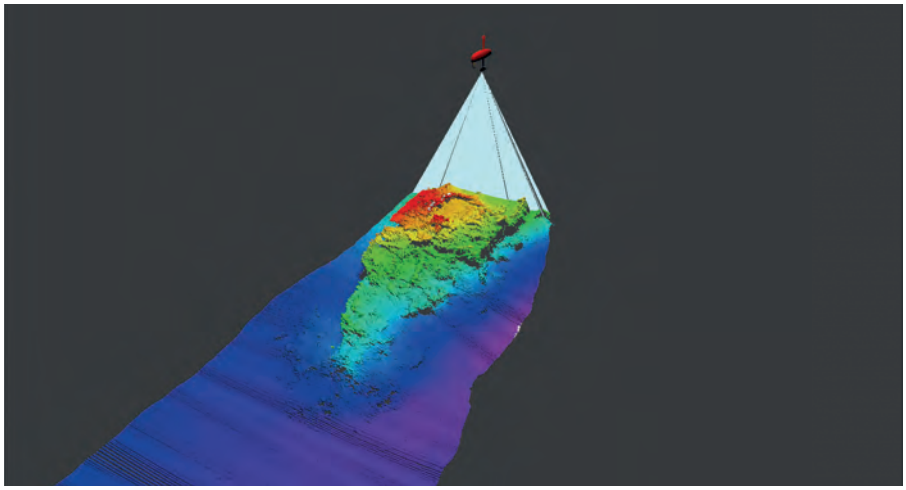
By David Vincentelli and Nicolas Gracieux, Exail, France

The development of unmanned and autonomous surface vehicles in recent years has triggered a new era in civilian and military maritime operations. One of the applications that is likely to benefit from this technological revolution is seabed mapping. Exail (formerly iXblue) decided to make maritime autonomy and remote hydrography a key technology priority in 2017, when it released its first DriX unmanned surface vessel (USV). Since then, the DriX USV has become a large commercial success, with more than 20 units built and sold around the world (USA, UK, Korea, Brazil, Poland, UAE, Japan, etc.), and operations in many more countries, such as Canada, Taiwan, Saudi Arabia, Bahrein, New Zealand and Tonga.

In a world that is in constant need of field-proven data but is also highly concerned about the impact of human activities, the environmental impact of shipborne missions hangs in the balance. The introduction of USVs helps the acceptance of such investments by considerably reducing the carbon footprint of the survey – an improvement of over 95% in energy consumption in the case of DriX. During a survey conducted in February 2023 in the Bay of Biscay, DriX covered 2,400 nautical miles in 12 days of operations, using 600L of fuel for the DriX mission and up to 2,000L for the associated logistics, mobilization and escort vessels in the visited ports. A comparison for the same client, who carries out this type of mission every year with crewed vessels, reveals that using DriX saved 200,000L of fuel.

USVs can be regarded as a force multiplier and complementary data collection subsystem to mother research or military vessels, or as a stand-alone tool working from port to port for dedicated mapping and environmental assessments. This capability allows key players to integrate USVs into their long-running survey routines and provides long maritime persistence at sea for new players with fewer investment capabilities.

Despite these successes and the return on experience gathered, some operators remain cautious about the potential risks – whether legal or operational – associated with the exploitation of such autonomous vehicles and technologies. Nevertheless, Exail has demonstrated over the years that the advantages of autonomous technology and unmanned vessels such as DriX considerably outweigh the potential risks. For Exail, the experience at sea has demonstrated that the risks associated with the operation of an unmanned vehicle can be reasonably mastered.



▲ *Visualization of multibeam echosounder data acquisition conducted by the DriX USV.*

Legal qualification for USVs

As far as we know, there is no current unified international definition of a ship. The United Nations Convention on the Law of the Sea (UNCLOS), signed in Montego Bay in 1982, refers in all its provisions to ships without providing a definition. Nevertheless, being qualified as a ship triggers many legal consequences. Ships are subject to many international and national conventions, such as laws and regulations concerning shipbuilding and design (with safety requirements), navigation (COLREG, SOLAS, STCW conventions) or maritime pollution (MARPOL convention and Hong Kong convention for vessel recycling). It also bestows rights and obligations: rules of navigation defined in the UNCLOS when sailing in national waters, EEZs or international waters, or conditions and limitations for performing survey or scientific missions in territorial waters, contiguous zones or EEZs.

Several of these legal provisions may be disproportionate for USVs, as we cannot expect unmanned platforms that are not designed to carry human beings (such as DriX) to strictly comply with the same safety rules as traditional passenger vessels. Similarly, the rules of safety at sea cannot be construed and applied in the same manner for traditional manned vessels and USVs. For these reasons, we believe that USVs must be considered as a new legal category. French law has selected this option, by adapting the existing maritime legal framework to the specificities of USVs. This will avoid the application of irrelevant provisions from the existing legal maritime framework, and thus protect and encourage the innovation allowed by USV development.

We must also consider the case of warships. In hydrography, many vessels belong to naval forces and therefore fall under the classification of a warship, as defined by Article 29 of UNCLOS . As discussed above for civilian ships, USVs exploited by naval forces cannot be considered a traditional warship due to the absence of a crew. Nevertheless, a military USV would act under the command of a naval force State organization (even remotely), could bear specific marks and could be included on a navy list. For these reasons, we believe it will be relevant to extend, with necessary adaptation, the current definition of warship to military USVs so that they can benefit from specific rights recognized by international law, such as immunity. For military USVs used for hydrography, this would be an interesting development that could help guarantee safer operations in sensitive areas.

▲ *DriX conducting a survey among fishermen.*

▲ *DriX operating near an offshore platform.*

Legal tools to safely operate USVs

Although no international legal framework is in place to regulate USV operations, various legal tools do exist (or will exist) to allow safe remote operations. Over recent years, and despite the lack of appropriate regulation, Exail has demonstrated its ability to successfully support its customers during their remote hydrographic missions with the DriX USV. Remarkable scientific results have been achieved, along with unprecedent savings in time and fuel compared to traditional surveys. The USVs have proved to be a mandatory yet complementary asset for hydrographic surveys, seabed mapping and oceanographic research.

On the contractual side, the use of knock-for-knock indemnity clauses makes it possible to allocate the risks of damage or loss to property or of death or injury to personnel between the parties. This cancels the risk of claim between the parties as a result of an incident involving a USV. Additional contractual provisions on liability limitation also help to reduce the risk.

With regard to non-contractual incidents or damage to third parties, insurance coverage is a second line of defence. As for manned vessels, USVs need to be insured through hull &

▲ *DriX acquiring hydrospatial data in a wind farm.*

▲ *DriX tested off the coast of Brittany, France, alongside the hydro-oceanographic ship* Beautemps-Beaupré.

machine and P&I insurances, or equivalent insurance coverages. Moreover, with the growing development of USV activities, many insurance companies are now able to provide interesting insurance coverage for USVs in terms of cost or implementation.

As a last point, good coordination with local authorities in the area of operations should also be considered. In the case of Exail, we regularly keep the concerned local authorities informed of our USV operations and even establish temporary agreements with local search and rescue services where possible, as part of our risk assessment.

As such, the lack of a unified legal framework has not been a definitive obstacle for Exail. Contractual and insurance tools have been very helpful, and the more recent emergence of new legislation on USVs is a key factor that will increase the possibility of USV operations.

French regulations on USVs

France provides a very interesting example of new regulations for USVs. This regulation, which has been built step by step since the Blue Economy Act of 2016 (Loi Leroy), enables successful collaboration between industry, operators and authorities. Recognizing the important impact that this new regulation would have on its survey operations, Exail actively participated in working sessions to develop the new regulation.

France now authorizes USV operations in its waters , officially for experimental purposes only, although business operations also go through the same permit process. The Prefectures Maritimes are responsible for providing these USV permits. For USVs less than 10m with a speed below 10 knots and with no cargo or passengers, permits to operate a USV in a defined area are granted upon simple declaration. For other USVs, prior authorization from the maritime authorities is required. Exail's DriX falls in this second category and Exail has therefore regularly applied for such permits since the issuance of this administrative regulation in May 2020. This procedure is likely to change in 2024 with the obligations of flagging and registration of drones to operate in French waters.

The next step was the ordinance law of 13 October 2021, which reformed French maritime legislation with rules on USV certification and flag procedures, insurance obligation, identification marking and liability regimes for USV operators and owners. The final step will be the entry into force, hopefully by the end of 2023 or in early 2024, of the practical administrative regulations on technical identification criteria for USVs, the certification procedure, the minimum safety equipment requirements for USVs and operator permits.

It is interesting to note that, based on our experience, this first attempt at USV regulation has not been an obstacle for survey missions. In addition, it has the benefit of familiarizing maritime authorities with the USV concept of operations through risk assessment and survey supervision. With growing USV activities, having authorities that are used to managing such USV operations might be highly beneficial for all present and future operators acting in French waters.

Note that French law distinguishes between 'maritime drone' and 'autonomous vessel' . We deem this distinction to be very relevant, as a drone without cargo or passengers should not be treated in the same way as a larger autonomous vessel with people onboard. The safety criteria for construction or sea-going must therefore also be different, to avoid disproportionate or irrelevant requirements for drones. Whereas the legal regime for drones is now complete and will enter into force soon, the legal status for autonomous vessels remains experimental (with a two-year limitation) and is far from being fully completed.

Thus, in the case of hydrography missions in France, it is currently easier to operate a unit classified as a drone rather than an autonomous vessel.

Status of operators

A last interesting point to be underlined is the status of USV operators. Indeed, behind the drones, the IA and the screens, there will always be a human who is legally responsible.

French law considers the USV operator as the captain in charge of commanding the USV (even if the USV is remotely commanded or under autonomous mode). To reduce their liability risk, French law has innovated with the application of liability limitation based on the LLMC convention of 1976 to the owner/charter/captain of the drone. Such a provision may reassure operators and owners regarding their risk while supervising USV operations.

In addition, to the extent that the USV operator acts within the scope and limits of their position, the liability shifts in the case of an incident to the owner rather than the USV operator. This legal mechanism also reinforces the individual legal protection of USV operators. The exception is if the USV operator's conduct involves gross negligence or willful intent to kill, injure or damage.

Considering the legal tools available in a context of emerging regulation, Exail and Exail's clients have successfully operated DriX in the territorial and EEZ waters of over 20 countries with differing maritime regulations since 2017. These include Azerbaijan, Tonga, Taiwan, Saudi Arabia, Brazil, France and the US. USV operators and Exail have adapted the documents that they use in the private sector (risk assessment, concept of operations) in the best way that they can to cope with this increase and heterogeneity in regulation.

Pending questions

Despite the progress made, many questions remain. For example, what happens when a USV sailing under the French flag enters the waters of another country? Will it be admitted as it is, or will it need to go through a local certification process first? This is a critical legal and operational issue that is, to our knowledge, far from being solved.

Also, if a USV is being operated autonomously from a remote operational centre (ROC), which law applies? Is it the flag jurisdiction of the USV, or the jurisdiction of the location of the ROC if these are not the same? Considering that the key element from which an incident and subsequent liability may result is the USV, we believe that the flag jurisdiction of the USV would be more appropriate.

Conclusion

With the entry into force of the last legal and regulatory provisions by the end of 2023, France will probably have one of the most comprehensive legal frameworks for USV operations in the world. At the same time, DriX clients and other autonomous platform operators have proven that the lack of an international legal framework need not be an obstacle to performing more agile, more efficient, and more environmentally friendly surveys that complement conventional survey vessel operations. ■

[1] We deliberately use the term 'unmanned' rather than 'uncrewed' as we consider that reference to the word 'crew' can create confusion about the nature of the concerned vessel. An unmanned vessel does not carry anyone onboard (no crew or passengers), whereas an uncrewed vessel has no crew but could can carry a passenger.

[2] Article 29 of UNCLOS defines a warship as: "a ship belonging to the armed forces of a State bearing the external marks distinguishing such ships of its nationality, under the command of an officer duly commissioned by the government of the State and whose name appears in the appropriate service list or its equivalent, and manned by a crew which is under regular armed forces discipline".

[3] Arrêté du 20 mai 2020 relatif aux modalités d'expérimentation de la navigation des engins flottants maritimes autonomes ou commandés à distance.

[4] Ordonnance n° 2021-1330 du 13 octobre 2021 relative aux conditions de navigation des navires autonomes et des drones maritimes.

[5] A drone is an unmanned surface or subsea vessel with a length between 1m and 16m, a speed of less than 20 knots, less than 100UMS gross tonnage, less than 300kJ of kinetic energy and without any cargo or passengers. Any unmanned vessel not complying with the cumulative criteria is classified as an autonomous vessel.

About the authors

David Vincentelli is a hydrographer, IFHS Chair and president of AFHy. He graduated with a Master's degree in Hydrography from ENSTA Bretagne in 2006 and worked at sea for seven years with Fugro. In 2012, he took on a business development and management position in the sea operation division at Exail, which is now fully dedicated to supporting the development of remote hydrography.

Nicolas Gracieux is deputy general counsel of the Exail group. Nicolas graduated in international business law and international relations from Paris Assas & La Sorbonne Universities and from the Paris Bar association, and joined Exail in 2016. With the development of the DriX USV since 2017, he is strongly involved in regulations for unmanned maritime systems, in France and abroad.

▲ *Remotely operating a DriX from the control centre.*

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Publishing date: 22 February

Issue 2: Platforms / Shipwreck Surveying
In view of the proliferation of platforms and their abbreviations in recent decades, how is the landscape of vehicles, surveying tools and sensor options evolving? This issue zooms in on shipwreck surveying as a way of preserving oceanic history through innovative platforms and methodologies.

Publishing date: 2 May

Issue 3: Robotics & Autonomous Systems / AI
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Issue 4: Business Guide / Seabed Surveying
The annual Business Guide is a comprehensive exploration of seabed surveying, presenting invaluable insights into the latest hydrospatial mapping trends from – and for – the global hydrographic community. This issue also provides an update on the progress of innovative methods and technologies for more effective seafloor mapping.

Publishing date: 28 November

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Embracing innovative technologies to meet growing demands

AI set to improve job security in the marine survey sector

By Richard Dowdeswell and Danny Websdale, GeoAcoustics, UK

In a March 2023 blog, Microsoft founder, billionaire entrepreneur and philanthropist Bill Gates said: "The development of AI is as fundamental as the creation of the microprocessor, the personal computer, the internet and the mobile phone. It will change the way people work, learn, travel, get health care and communicate with each other. Entire industries will reorient around it. Businesses will distinguish themselves by how well they use it."

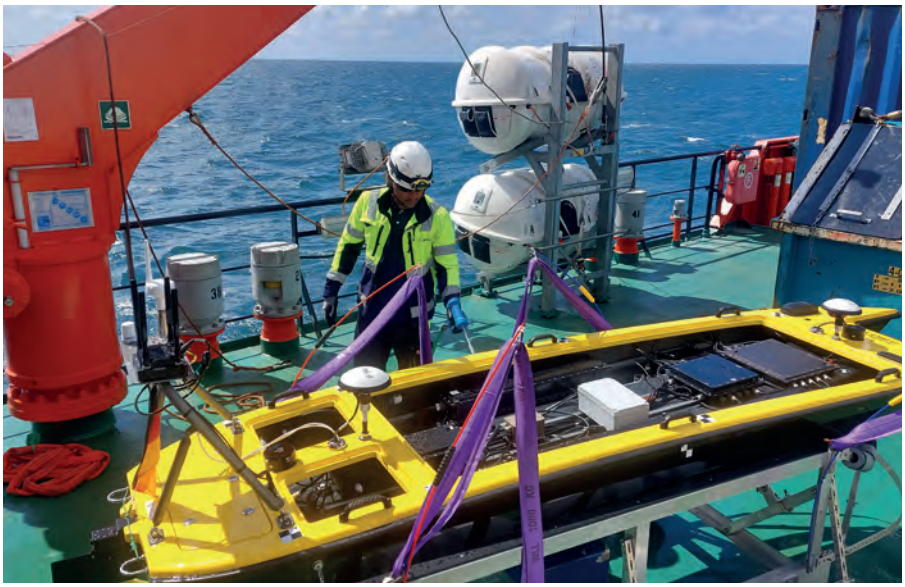
New workflows that leverage artificial intelligence to achieve the same results as a human being but faster and cheaper will create job losses. From telemarketing to bookkeeping, there really is no stopping the 'rise of the machines'. Job losses have already happened and there will be many more. However, AI replacing highly skilled workers – like marine surveyors – is far less likely.
AI will certainly transform marine survey and other subsea sectors, but it cannot replicate the nuanced understanding and decision-making capabilities needed to acquire marine data efficiently. However, it will make the job easier and help surveyors to operate more effectively over a larger area, and it will take less time to acquire data than it used to. When used properly within an optimized workflow, from streaming the seafloor to producing the final geophysical product, AI will be responsible for massively improved operational efficiency. As a result, business performance and subsequent job security will improve too.

Lack of human resources

The use of AI to enhance marine data acquisition comes at a time when there is simply not enough available human skills and experience to go round, even with the graduate surveyors joining the industry.

This has a lot to do with growth in the offshore wind sector, with new wind farms requiring significant amounts of bathymetric and sub-bottom data for planning and development. Furthermore, once a wind farm is up and running, it is common for the data to be updated at least once a year to ensure safety and inform operations & maintenance (O&M) regimes.

To put the size of the marine survey task into perspective, consider that the global offshore wind capacity is projected to rise from 34GW to 330GW this decade. This will drive the installation of more than 80,000 new fixed or floating moored turbines (based on an average capacity of 3.4MW). Each and every one of these turbines will depend on accurate and regularly updated seafloor data for its entire lifetime, which could easily be 30 years or more.



▲ *Preparing a Mantas T12 USV for autonomous data acquisition at an offshore wind farm.*

▲ *Real-time AI data streamed to the wheelhouse means data quality can be checked easily.*

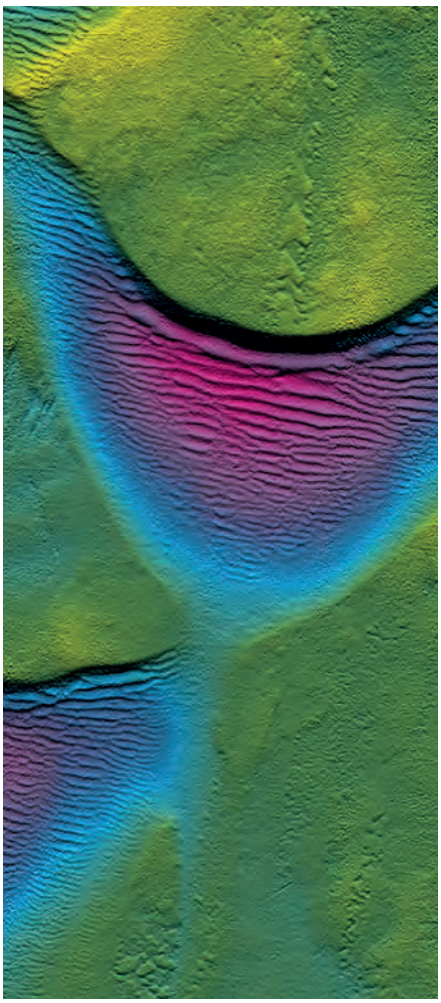
Such incredible growth in global wind energy production presents a fantastic opportunity for marine survey and related industries. But for survey businesses to transform demand for their services into revenue, they must have and be able to demonstrate their capacity to take on the new work, which is where innovative technology, including AI, will really make a difference.

Leveraging AI to meet demand

This is the objective behind the development of a new hands-free AI-powered data processing system for the GeoSwath 4 bathymetric sonar. In development since 2020 through an Innovate UK Knowledge Transfer Partnership between interferometric sonar manufacturer GeoAcoustics Ltd and the University of East Anglia, the new AI released this summer is one of the first to deliver fully automated processing of bathymetric data in real time and on board. The AI saves time and money during a survey and at the post-processing stage by allowing a high-quality livestream of the seafloor via the GeoSwath 4 sonar. The new capability does not negate the need for a marine surveyor, however. What it does do is help the surveyor collect higher quality data in a more efficient manner. Because the 'raw' data is filtered with AI the instant it is received, surveyors can make better decisions with the improved information. It cuts out the 'dirty work', allowing professionals to focus on data quality and surveying efficiency.

This includes whether the acquired data is likely to meet IHO specs. By using the AI-powered Survey Accuracy function, surveyors can determine any data gaps within the survey and mitigate these while on the vessel, rather than back on shore in the office. Having the quality-controlled information instantly can therefore speed up the entire process, which reduces costs and frees up human resources to work on more projects. Considering the growing demand in the market being driven by offshore wind, such efficiencies lay the foundation for taking on more work than would be possible without the support of AI.

The streamlined AI-enabled workflow has environmental impacts too. Should the data not meet the quality threshold for a particular survey, the vessel can be directed to redo survey lines until the required quality is achieved before it heads home. Without this ability, a second trip to the site, using more fuel and costing more money, would normally be needed to address any issues found with the collected data back in the office.

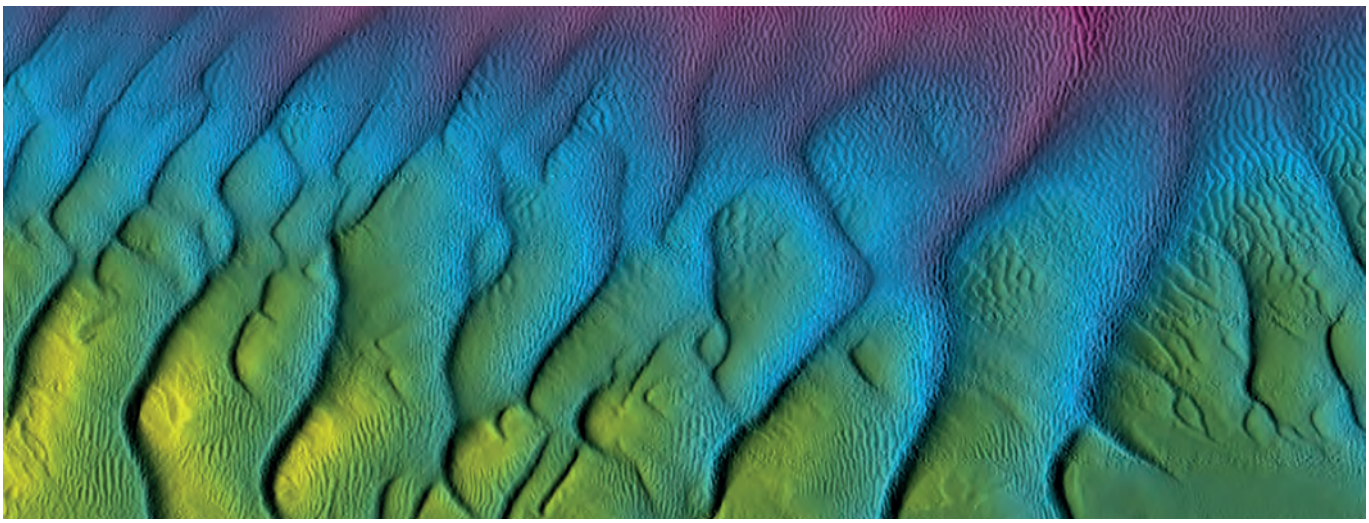


▲ *Data acquired by a professional team with the help of AI.*

The surveyor's virtual co-pilot

Microsoft describes the use of AI as like having a co-pilot. Already available via the Edge browser, its AI can enhance general working, for example by helping with writing emails and managing inboxes. The term is even more fitting in the context of marine surveying, as data-processing AI can perform the role of a co-pilot for autonomous vessels. While the GeoSwath 4 AI is self-contained and applied solely to cleaning data in real time, there is potential in the long term for hydrographic sensor and instrument AI to communicate with the autonomy controllers that direct uncrewed marine survey platforms, whether on or below the surface.

Even when autonomous vessels become more commonplace, the gainful employment of marine surveyors will not be at risk. The vision is that autonomous surveying can streamline workflows to further speed up data acquisition and therefore reduce costs,



▲ *The data was preprocessed by AI, speeding up post-processing.*

while allowing the available human resources to be more centralized. The job spec may change, but demand for the same skills and experience in an operator or supervisor will be just as strong as it is without the highly evolved autonomous technologies of the future.

In fact, it is only in sci-fi set in the far future where humans are not in the 'autonomy loop'. This is because, in today's reality, nothing can replace the ability of a professional to make decisions based on their personal experience and ability to recognize the nuances at play in a given situation. It is interesting to see that in his blog, Bill Gates noted that: "they [AIs] also make factual mistakes and experience hallucinations." AI is fallible, and it is easy to agree; anyone using generative AI such as ChatGPT in any depth, especially in technical matters, will soon find that its answers cannot be taken for granted and should not be trusted without verification.

GeoSwath 4 does not use the same type of generative approach as the new wave of online AI tools, and its clear focus ensures that it can be trusted to process data accurately. However, other AIs in the operational chain of autonomous marine surveying might need to make decisions that could affect both quality and safety. Human interaction and intervention will therefore always be needed, whether to address data, operational or navigational issues.

In closing, it is worth looking back in time. Subsea industry history shows that fear of robots taking over is unfounded. Take the case of remotely operated vehicles (ROVs). First used in the 1960s, there was considerable concern that divers would be put out of work by these strange new marine robots. But this never happened. Instead, underwater contractors developed a hybrid approach where the best aspects of divers and ROVs were used for the underwater inspection or repair jobs they are most suited to. Likewise, AI is very much suited to processing bathymetric in real time, while marine surveyors are infinitely better at taking decisions, managing teams and acting on the bathymetric data received. This is why jobs in the marine survey sector will not be negatively impacted for decades, probably even centuries, to come. This only leaves the option to embrace AI, and enjoy the support of a tool that makes life easier and can in fact improve job security. ■

Read more

The Age of AI has begun, Bill Gates
https://www.gatesnotes.com/The-Age-of-AI-Has-Begun

About the authors

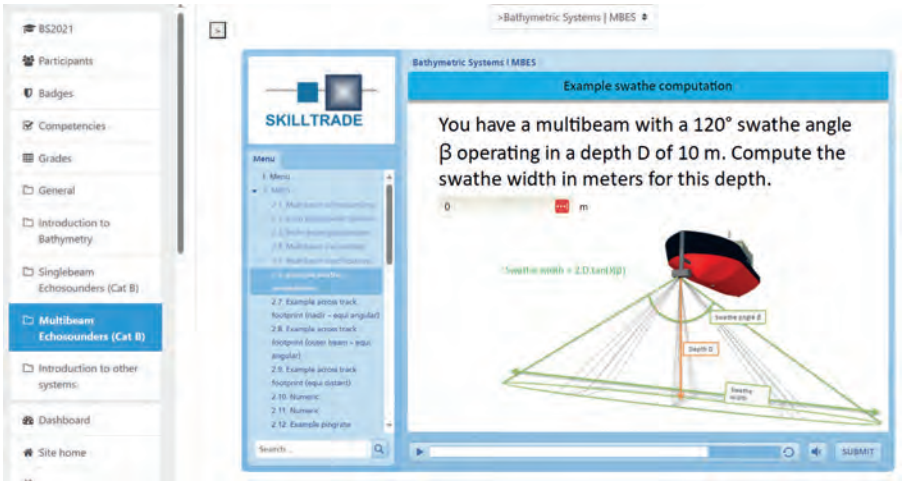
Richard Dowdeswell is chief commercial officer of GeoAcoustics Ltd. He joined the company in 2017 and led the buyout from Kongsberg in 2020. Prior to GeoAcoustics, he spent ten years working for the UK Government's Centre for Environment, Fisheries and Aquaculture Science (Cefas) in a range of roles, including running the organization's subsidiary technology development company. Before leaving Cefas, he was responsible for business development in the Middle East and was instrumental in winning several contracts and establishing Cefas' first overseas office in Kuwait.

Danny Websdale is an AI/ML research scientist at GeoAcoustics Ltd. He received a BEng degree in computer systems engineering (2014) and a PhD in audio-visual speech processing (2019), both from the University of East Anglia, UK. His current work focuses on applying AI for real-time sonar applications.

Bathymetric sensors in education

By Huibert-Jan Lekkerkerk, technical editor, Hydro International

The position of bathymetric sensors in hydrographic education is beyond discussion, as bathymetry is, was and will continue to be the bread and butter of the hydrographic surveyor. Bathymetric sensors are also the most difficult instruments to train students on, simply because they need to be powered and placed in the water. All very logical, but a challenge if you want to demonstrate every aspect of the sensors to students.



▲ *Displayed here is an e-learning module focusing on the subject of bathymetry.*

▲ *As an integral part of their education, MIWB students acquire advanced knowledge in underwater acoustics, applying their understanding not only in theory but also through practical application with the Acoustic Simulator.*

It is for these reasons that training on these sensors starts with theory. Both at Skilltrade (Cat-B) and the Maritime Institute Willem Barentsz (MIWB, Cat-A) in the Netherlands, the theory is provided in a blended form. Students receive an introduction to the subjects of underwater acoustics and bathymetric sensors from a lecturer, after which they follow an e-learning course with much more detail and a series of assessments on the subject. In both cases, the theory is concluded with a theoretical test.

However, this only proves that the student should be able to understand bathymetric sensors. They have not necessarily operated them in the real world. And it is this operation, as stated, which can be a bit of a challenge. For a simple understanding, the students start with the simple measurement of water depth with a lead and line. Together with tidal data, this allows the student to compute the first depth related to a datum.

The next step is working with actual echosounder data. Even in its most simple set-up, this requires not only an echosounder but also a computer with software and positioning system and, in the case of multibeam, a gyro, sound velocity probe and inertial measurement unit. These are needed not so much for the echosounder settings but to create reliable data. Otherwise, it is hard for students

to relate measurements as seen on the echosounder to the final product (an aside to old hands: manual scaling and plotting depths on a piece of paper are skills no longer taught at school it seems, and the industry also seems to have all but forgotten about them).

Students start by mobilizing the echosounder in a workshop, testing it in a tub of water to figure out the settings and interfaces. After that, the system is brought to the vessel and installed together with the other equipment. Then it is time to carry out the various calibrations and so on. On the Cat-B programme, there is little time but we work with professional students who in general require less time before getting to the practical aspects, and in most classes there are a few experienced surveyors who can give a hand. On the Cat-A programme, we work with students fresh out of secondary school who usually have no experience with the practical work at all.

The longer programme for these Cat-A students allows us to gradually increase their knowledge. Students start in their first year of training by simply looking at the installation created by the second-year students. No theory yet, just getting an idea of what it looks like. Then, at the end of the first year, students install and operate the instruments under the guidance of the second-year students during a two-week survey project around the local harbour of Terschelling. This is basically no more than 'button pushing'.

In the second year, students first follow in-depth sensor theory, after which they get to install a system 'without consequences'. That is, they do not need to produce any data. They go through the process of finding out for themselves how things work, and can make mistakes during this very short initial experience of a few days.

After this, it's time to augment their knowledge with all the other systems and the software to 'get it right'. To test their newly acquired knowledge, we put the students in the simulator. The nautical simulators at the MIWB have been 'tweaked' to output various survey data from the simulated environment to a survey computer. The students now set up the software and start to gather bathymetric data of the simulated environment, which they work into a final report and chart. At this point, they have operated the echosounder (for a short while) and set up and operated the software.

After this simulator project, the students are ready to try their hand at the real sensor in a real environment. They redo the project from the first year with one major difference: rather than being guided and pushing the buttons as instructed, second-year students are now responsible for the installation, calibration, operation and data processing. This also means applying all their knowledge and transferring enough of it to the first-year students to ensure an effective survey team. After concluding these two weeks, the second-year students are ready for their internship, where they will apply their knowledge to real-life projects all over the world.

After their 100-day internship in the first half of their third year, the Cat-A students return to the school benches. As part of their training, they obtain advanced knowledge of underwater acoustics, but not just in theory: using our Acoustic Simulator, the students evaluate various measurement methods and their accuracy and limitations. This gives them a deeper understanding of how the systems work.

At the end of the third year, they complete a complex project (just as the Cat-B students have done), where they once more perform a survey utilizing various sensors. While during the second year the lecturers helped with any issues, in the third year the students need to complete the project alone. This 'Oosterom' survey is always a challenge, as it requires not just knowledge about the various systems, but also timely planning and human resource management. This is generally a much bigger challenge for regular Cat-A students than for the professional students of the Cat-B programme, who go through the same process.

So, how do you train students on bathymetric systems? In a sound, practical way using in-depth theory – pun intended. ■

▲ *Skilltrade students at work, meticulously inspecting the multibeam depths.*

About the author

Huibert-Jan Lekkerkerk serves as the technical editor of *Hydro International*. He is a freelance hydrographic consultant and author of several publications on GNSS and hydrography. Additionally, he is the principal lecturer in Hydrography at Skilltrade (Cat B) and the MIWB (Cat A).

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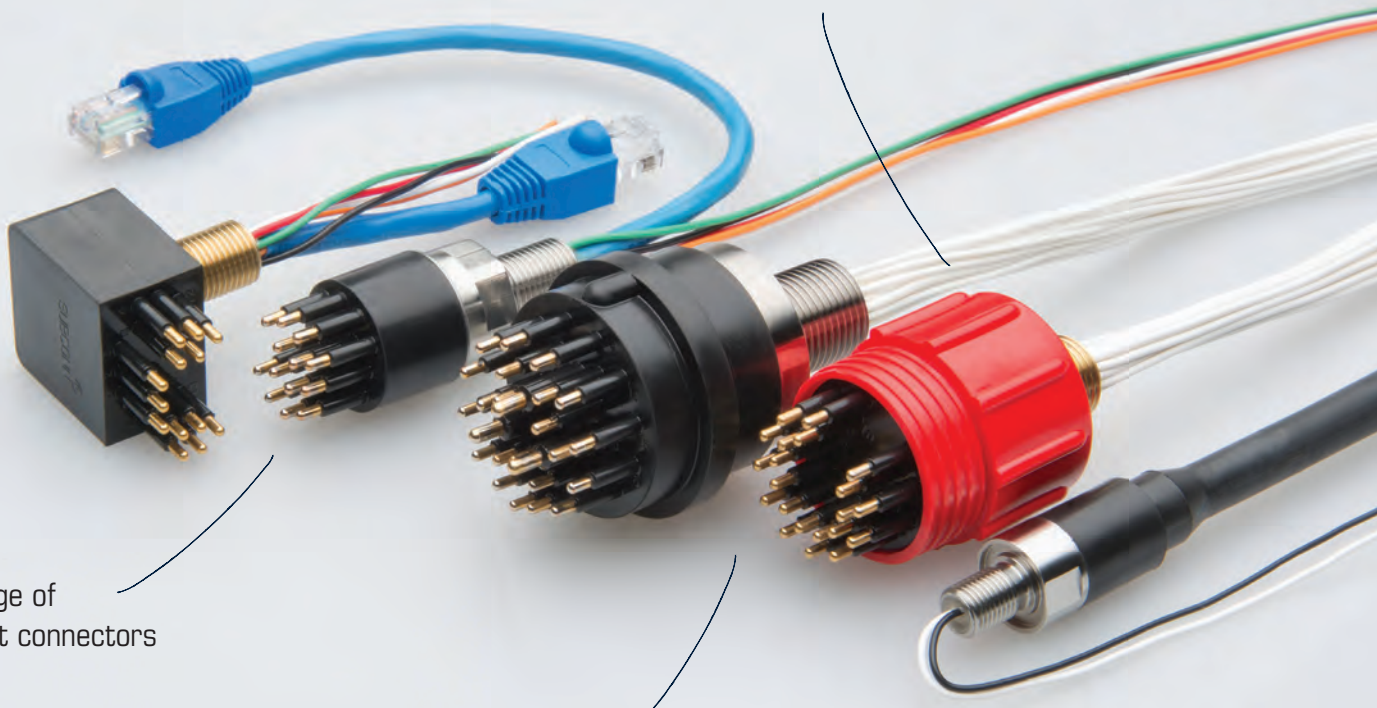

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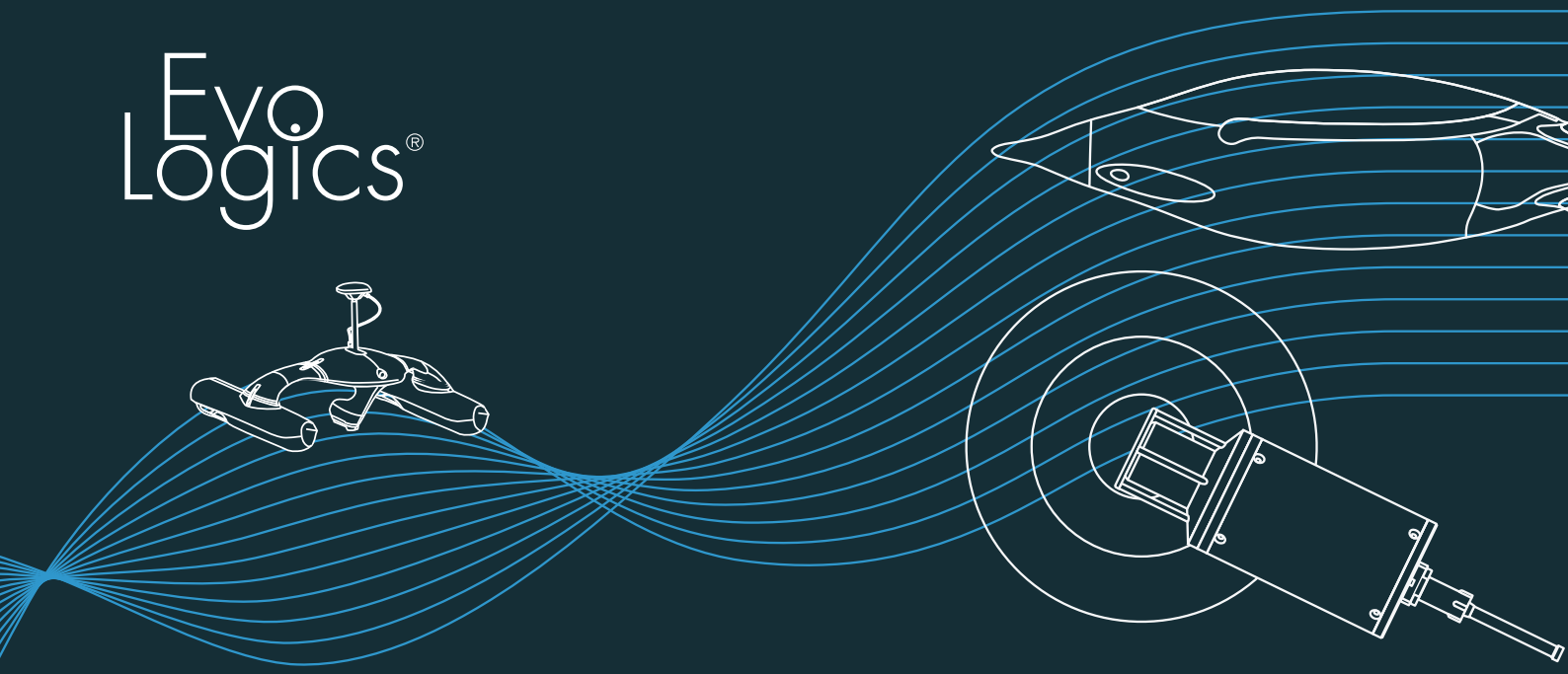

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